The Welding Engineer

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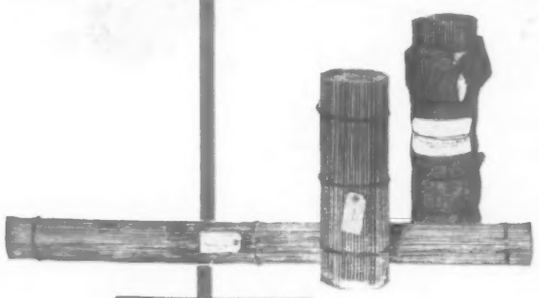

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Your Industry

YOURS is an industry within many industries. It is one which during the past year has had a tremendous influence toward preventing the unemployment situation from becoming positively disastrous. The inner-circle of your industry is composed of men who are looking ahead and making new discoveries and interpreting these discoveries in terms of possibilities for improving human welfare. These interpretations are passed on to others to be refined and then advertised and finally put into use. In spite of its extreme youth, your industry has been an outstanding leader in the field of redesign. Its accomplishments in that direction have won the admiration and respect of the whole industrial world. Some of its accomplishments have also won the gratitude of older and more basic industries which have been able to continue production on account of new possibilities which are directly traceable to research work in the application of various welding processes. Your industry has been able to maintain a high level of activity during the months of general curtailment. It is not at the end of its resources. There are signs of future progress in every direction. Your part is to get acquainted with every phase of your industry and learn how to take an active part in further progress instead of falling behind as your industry forges ahead.

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EDITORIAL

A New Era in Pipe Welding

IN SPITE of all that has been written about the advantages of welding pipe in buildings and the number of successful installations of piping which have been welded, there are some authorities who estimate that the process has only been used to about one per cent of its full possibilities. The application of welding in this field is bound to grow, so that this ratio would surely increase from year to year. However, there are some comparatively recent developments which promise to accelerate this growth and really pave the way for a new era in pipe welding. One thing which has handicapped the progress made in this field has been the lack of properly trained operators. This condition has been remedied to a large extent by the inauguration of training courses for pipe welders in scores of cities and towns in the United States, most of this training being given to men employed in the plumbing and steamfitting industries. It is safe to say that where there was one steamfitter two years ago who knew how to weld pipe, there are now at least fifty and probably one hundred. This training work has received further impetus as a result of the activities of the Heating and Piping Contractors National Association. Another obstacle in the field was a general lack of understanding on the part of contractors as to just how the process should be used. This obstacle in turn is being removed by the simple expedient of drawing up a suitable code to govern every phase of the operation. Another difficulty which was especially serious to the small contractor was that of making special joints for turns and intersections. The making of templates for many of these special connections is difficult enough in itself, and added to this is the fact that it takes some time to develop skill in the use of templates and fabrication of such special types of joints. This problem has been greatly simplified by the appearance of a variety of stock fittings for the most common types of joints, such as bends, intersections, reducers and closed ends for pipe. There are at present on the market enough of these various types of fittings to make a good many complete installations possible without using anything except an ordinary line joint. The number of such things available is increasing, which means that the number of difficult pipe welding problems is decreasing. The far-reaching effect of these three developments in the pipe welding field is sure to be in evidence whenever building activities are increased to anything like a normal program.

The Spring Meeting

A STATEMENT made by President E. A. Doyle at the Spring Meeting of the American Welding Society, to the effect that during the past twelve months the membership had steadily increased to a new high record will of course be gratifying to the entire membership of that organization. It is likewise good news to all those who are interested in the advancement of the welding processes, because it indicates that the work of this group is becoming more and more effective and is receiving the cooperation of a constantly increasing number of individuals and firms in the metal working industries. Added to this general indication of progress is the fact that practically every paper read at the technical sessions and practically all committee reports showed definite progress in various important fields. Those who have been working with little visible encouragement for the past ten years on the pressure vessel problem began to see their labors getting ready to bear fruit. They saw the draft of a code allowing the use of welding in unfired pressure vessels and power boilers rapidly getting into shape for official approval, with the possibility of safe welding recognized and the discussion centering mainly upon safeguarding this application in order that there should be no failures due to the use of welding in this field by incompetent firms or individuals. In the technical sessions were papers indicating the practicability of the use of welding on important structures, as shown by actual experience. Another important field touched upon in the technical sessions is that of structural steel. It is noticeable that the investigations have gone beyond the stage of tests for safety and are now concerned with fundamental design problems. In the industrial piping field, there is likewise evidence that progress has advanced beyond the point of selling the process and that it is becoming a question of agreeing upon a safe and practical program of application. In these important fields the use of fusion welding is practically in the pioneering stage as far as actual use is concerned. The American Welding Society has made possible a considerable amount of intelligent group effort to establish the use of welding in these fields on a sound basis, and undoubtedly it can attribute its continued growth in membership to a natural response on the part of industrial men to such constructive work. It would be an injustice to name here the various contributors to the excellent program at the spring meeting without naming all of them. It takes a thoroughly successful organization to produce a series of meetings of such uniform high quality.

Steel Founders Not Downhearted

ALTHOUGH it is difficult to restrain the zeal and enthusiasm of those who see an industrial revolution in every new discovery without appearing to be a "wet blanket," it is just as well to face the facts in promotion work and refrain from making statements which are so far fetched as to create a strong feeling of doubt on the part of those who are well informed. An authority in the structural steel field, for example, does well to point out that the continued progress of structural steel welding does not mean the sudden elimination of all riveting work on steel structures. His advice to the welding enthusiasts to be reasonable and rational in their claims and to recognize the present importance of the riveting method of assembly is well worth considering. It suggests that the logical way to increase the use of welding in structural work is to start at the bottom, and intimates that there are plenty of experienced engineers who do not like to be asked to believe that the start should be made at the top. Another field in which some very broad statements have been made is the casting field. The Steel Founders Society recently questioned a number of steel founders and have reported that 88 per cent of those who answered the questionnaire do not consider the welding process a serious competitor, and 77 per cent of them do not believe that the process will become serious competition in the future. Most of the founders recognized, however, that the use of welding is sure to have a steady growth and that it will have a field of application of its own. It is quite certain that in industries like these the welding processes will secure a good volume of new work, but for the sake of being more easily believed in promoting these processes, it certainly seems wise to recognize that developments are bound to be comparatively slow instead of revolutionary, and that other processes are not prepared to lie down and die just to be accommodating.

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Practical Aspects of Pipe Welding*

A Study of the Fields Where Welded Piping Is Becoming the Standard Shows It to Be a Real Improvement Rather Than a Cheaper Substitute

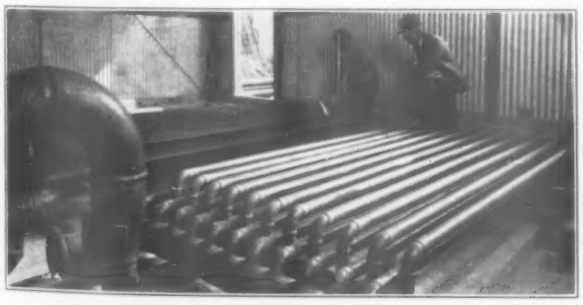
By R. E. Fritsch†

THE development of the application of oxy-acetylene welding in the fabrication and erection of piping has progressed rapidly in the past year. In the promotion of this interesting field it was found that the old adage held true—"We must crawl before we walk." Careful research on the part of the manufacturers of welding gases and equipment, and the co-operation of these organizations with designing engineers, piping fabricators, piping contractors, and the promotion of welding schools have lifted this youngster from the crawling stage and he now stands solidly on both feet—ready to take his place among the ever increasing group of oxy-acetylene welding applications.

The piping field is broad and any discussion must necessarily be properly divided to better trace the progress made.

Due to the multiplicity of piping used in the petroleum field and the advantages offered by the oxy-acetylene welded joint, together with the progressive nature of engineer in this field, welding was readily accepted and has been applied as in no other industry. Beginning at the source of the raw material, the oil well, we find the welded joint receiving careful consideration. While the nature of the piping around the well apparently limits this field for welding, it nevertheless offers certain opportunities. Welding casings while drilling wells has been done but in a few instances only. There is a field here for welding that apparently has not been developed.

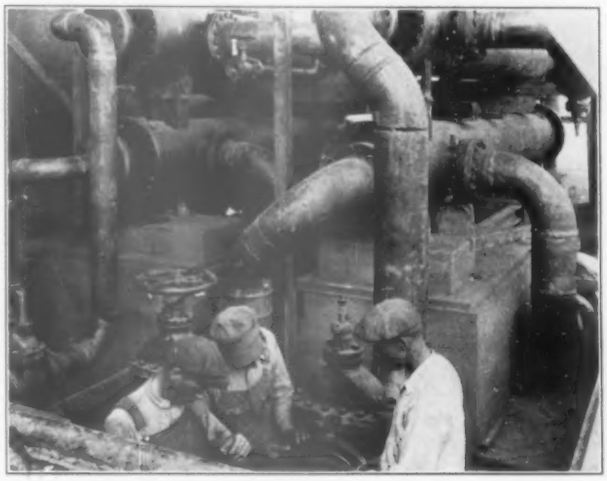
The next field—transportation of the crude oil to the refining centers—has progressed rapidly in the application of the oxy-acetylene welding of piping. The welding of long cross country oil lines has been widely discussed, but the most interesting feature of these lines where oxy-acetylene welding and cutting have played an important part often has been overlooked. I refer to the fabrication and erection of pipe line manifolds at the line pumping station.



Finishing Up a Welded Superheater for an Oil Company.

Simplicity in design, speed in fabrication and erection are the advantages offered by the use of the oxy-acetylene cutting and welding torch over other designs. Barrels, headers and the various manifold units usually are shop fabricated and assembled in the field. Much lighter in weight than previous methods of construction, the welded manifold apparently has proven more economical in both first cost and maintenance costs. A decided advantage is the flexibility of the welded manifold—this is especially true since the introduction of stock fittings for this type of work. The welding in itself permits changes with a minimum amount of expense and trouble and in conjunction with proper fittings for welded pipe lines these changes can be properly made with maximum economy.

At the present time there are under construction two large pipe lines which will carry crude oil from the Mid-Continent field to refineries located in the Central and East-central part of the country. There are 23 pumping stations in these two lines and in all of them the manifolds will be fabricated by using the oxy-acetylene welding and cutting torch.



All These Oil Refinery Pipes Are Easily Accessible Because They Are Welded.

The next step in this interesting field is the refinery. Wide acceptance of the oxy-acetylene welded pipe joint by many larger refiners has been the result of careful study of the advantages offered by the method. Piping which conveys hot oil and vapors at high temperatures and pressures must be leak-proof to provide maximum safety. Other features are of secondary importance.

It was recently the author's pleasure to inspect a large, modern refinery which had just been completed. For various reasons photographs of the piping are not available. Several outstanding features brought to my attention are worthy of mention at this time, since so far as we know this is the largest recent installation in this country where the oxy-acetylene welded pipe joint was used to its fullest advantage.

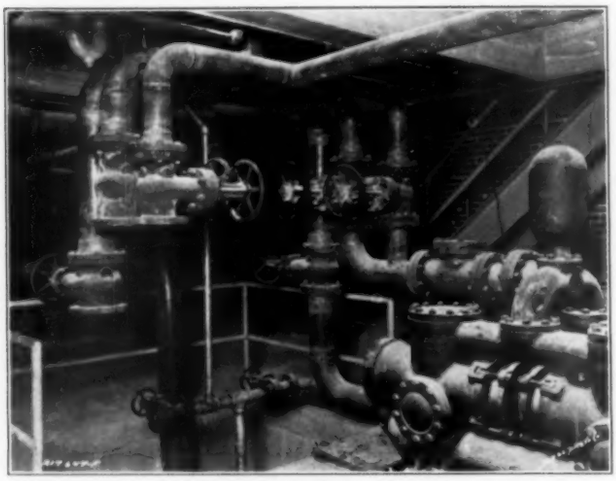
The problem of securing satisfactory welders was important. Approximately 3,500 applicants were tested, from which a crew of 80 was chosen. The customary test was made—each applicant was required to make a stationary or position weld in two short pieces of pipe, under the observation of the welding foreman. From the test unit coupons were cut and inspected and pulled in a testing machine. Each weld in the piping was marked by the welder and all welders took periodic tests to check up on their ability. Out of some 100,000 welds less than 50 leaks were found. In the condenser coils, which were made from 2-in. extra heavy pipe, some difficult welding was necessary since these coils were designed on the close centers of only 4 inches. One end of the return fitting was welded on the ground to the straight pipe, The other end was welded in position.

*Read before the 31st annual convention—International Acetylene Association, Chicago, Illinois—November 12, 13, 14, 1930.

†Tube Turns, Inc., Louisville, Kentucky.

The welding procedure of this particular refinery is somewhat unusual. The specifications covering the dimensions of the weld provide that an unusually heavy reinforced weld must be made. It is felt that in this way a strength of 120 to 130 per cent of that of the base metal is secured in 90 per cent of the welds. Any imperfect welds test out at least equal to the base metal strength.

It is logical to assume that the next few years will show a decided trend toward long cross country pipe lines for



Welding Greatly Simplifies the Installation of Power Plant Piping.

carrying refined petroleum products. Lines for carrying gasoline are now a reality, and two of them are now under construction. Oxy-acetylene welding will play a prominent part in the building of these lines, and the possibilities of this field are well worth our careful consideration.

Getting closer to the market, we next find the bulk station where petroleum products are stored for distribution by truck or tank car to the consuming centers. Considerable piping is necessary to convey the various products. Steam lines are necessary to warm the heavy, viscous fuel oils in cold weather so that they can be pumped more easily.

One other field in connection with petroleum and petroleum products is beginning to turn to the oxy-acetylene welded pipe joint. Certain restrictions, however, at this time limit the use of the welded joint in this, the marine field. The use of the oxy-acetylene welded pipe joint in river packets is also becoming more extenesive.

The welded pipe joint in the piping used in natural gas and natural gasoline fields also has found wide acceptance. This field resembles closely the handling of petroleum and petroleum products. The manufactured gas plant also has found the oxy-acetylene welding and cutting torch a handy tool in overcoming piping problems.

The distribution of gas throughout our cities is a pioneer field for the welded pipe joint. Reduction of leakage in mains and service lines has made the welding of pipe joints in this field almost universal. Much of this piping is exposed, and neat appearance is a necessary feature.

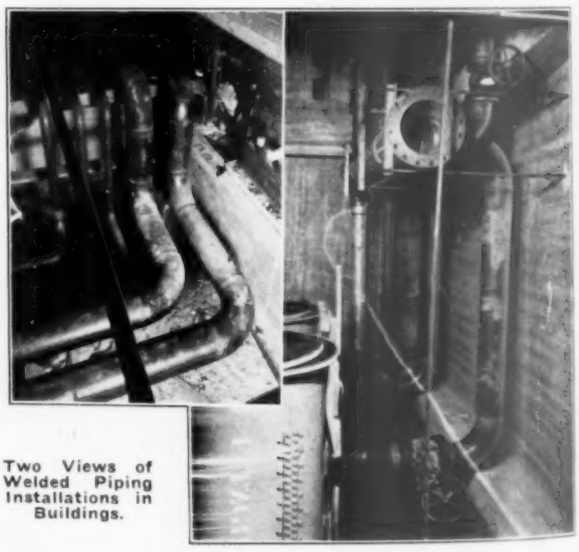
The steam piping field presents by far the greatest possibilities for the application of welded piping from the low pressure heating installation to the high pressure power plant.

Let us first consider the welding of steam piping in the heating field. The use of central stations for steam heating in crowded downtown business sections is increasing rapidly. The annual report of the Distribution Committee before the Convention of the National District Heating Association in June, 1930, showed that out of seventeen companies distributing steam in the largest cities in this country, only one was not using welded joints in mains and service lines. The outstanding difficulty encountered in this field is the problem of laying new mains through congested streets in the downtown section. The oxy-acetylene welding and cutting torch simplifies the problem and makes it possible to get around uncharted sewers, water and gas lines, etc., when these are encountered.

The use of the oxy-acetylene welding and cutting torch in the fabrication and erection of steam heating systems has spread rapidly in the past year. Here again close co-operation between the manufacturers of welding gases and equipment and the Heating & Piping Contractors' National Association has done a great deal to overcome the obstacles which have been encountered up to this time. We have been told that the "Welding Manual" which is now being prepared by the Welding Committee of the Heating & Piping Contractors' National Association will be completed and ready for distribution. Mr. John Zink, who presided as Chairman of the Piping Section at the meeting last year, is Chairman of the Welding Committee of the National Association, under whose direction this manual is now being prepared.

In view of the wide extent to which welding has been used in the steam heating field, we will limit our discussion to outstanding buildings of the past year. All pipe 6-in. and over in the heating system of a large New York office building was welded, allowing fabrication on the job of complicated units.

A most interesting building is now being erected in New York which according to the engineers has been designed for a life of not less than 100 years. I have reference to the New York Hospital and Cornell Medical College Association Buildings in New York City. All piping 2½-in. and larger on steam, exhaust, steam return, hot water, heating apparatus and brine systems, in the power house, tunnels, sub-basements, sub-sub-basements, apparatus rooms and houses, apparatus stories or spaces between stories, pipe spaces between stories and all main risers 2½-in. and larger will be welded. The heating and ventilating engineers on this large project give the following reasons for specifying the welded installation—in general, the welding method is much the better one. A welded installation insures tightness of the joints and their permanence and in this way eliminates a great deal of maintenance cost. The engineers feel that these features



Two Views of Welded Piping Installations in Buildings.

have been definitely demonstrated and that to this degree at least the advantages of a welded installation over a threaded installation must be completely recognized. Their feeling is that a welded joint once made will remain in that condition for practically the life of the pipe line, whereas a screwed joint, even though properly made, is subject to deterioration more rapidly than the piping system of which it forms a part.

The entire project will cover three city block in one direction and one entire block in the other. At least three years will be required to complete the work. In the entire project it is estimated that there will be about 10,000 welds and about 3,000 branch outlets. From this it can be seen that cutting will form a large portion of the work to be done with the torch.

The process industries use multifold piping presenting an interesting, and a very large field, for the use of the welded pipe joint. Textile mills, paper mills and many others offer

With Tube-Turns and Straight Lengths of Pipe, Any Assembly Needed Can Be Made Up Right on the Job.

considerable work for the welding and cutting torch and the progress made has been gratifying.

The next step in the steam field brings us to high pressure power piping installations. Due to the high pressures and temperatures, engineers have been reluctant to permit the piping contractors to weld installations of this kind, and for obvious reasons the high pressure steam field will require intensive effort along the lines of research before the welding of high pressure joints will be used more generally. It is the feeling of power piping engineers that the mechanical method of joining pipe has been worked out after years of careful study and until welding can prove conclusively that it offers advantages superior to those now made possible by the present type of joint, the change will not be given serious consideration. It is the general feeling that under certain conditions the shop weld, made under thorough supervision and subjected to the proper tests, may be used.

The advantages of the oxy-acetylene torch in the fabrication and erection of piping for high pressure and high temperature steam service are worthy of careful consideration, and progressive engineers throughout the country are deeply interested in developments which will make it possible for them to be assured of satisfactory performance on the part of the welded installation as they now are of the piping installed under present methods. Some confidence will be instilled as welding in low pressure work increases. An actual high pressure installation, in which the pipe joints have been welded in the field, will also tend to build up confidence in this method.

A power plant is being designed by one of the leading New York engineers for a 400 lb. boiler plant, in which all of the piping will be oxy-acetylene welded. This step will be extremely helpful in promoting the use of welding in the high pressure steam installations, although there will continue to be many difficulties which must be worked out before the welding of high pressure steam piping will become general practice. Most engineers, who are reluctant to permit welding in steam lines, even in low pressure work, have some time in the past had an unsatisfactory experience with welding.

The 200-lb. installation at the Bureau of Standards which was oxy-acetylene welded throughout has been in service about 18 months and the installation has proven entirely satisfactory. Welding was not included in the original design of this pipe but it was later changed over to an all-welded installation, and some of the outstanding features were as follows:

The estimated weight of the original boiler header was about 18,000 lb. against the actual weight of a welded header of 10,500 lb. This meant a reduction in weight of over 7,000 lb. in the header alone, and it was estimated that on the entire installation, in view of welding, over 10,000 lb. less material was raised into place. This is an important factor and emphasizes the economical advantages of the welded construction so far as first cost is concerned.

The use of the cutting and welding torch in making changes in power plant piping is one of outstanding value.

The insulating of high pressure and high temperature steam piping is decidedly simplified in the welded construction.

The use of the oxy-acetylene welded pipe joint in the refrigeration field likewise is becoming more general.

There are many other less important fields where considerable piping is used and where the oxy-acetylene welding torch has made considerable progress. Many equipment manufacturers who have been experiencing difficulty with castings have found that after careful analysis the designs can be changed to permit the fabrication of the piping in their units by means of oxy-acetylene welding, resulting in a decided improvement of the product. We have reference here to manufacturers of Diesel engines, laundry machinery, evaporators for special process industries, etc.

The use of chrome-nickel steel piping in process industries, where unusual problems of corrosion are encountered, has brought into the field a number of specialists in the welding of tubes made from this material.

Generally speaking, progress in the last year has been gratifying but there are yet a number of problems to overcome. Many engineers as yet are not prepared to write a welding specification and while the condition is rapidly changing, there is not yet a sufficient number of reliable pipe welders available throughout the country. The demand for good welders in some of the larger cities is much greater than the supply. The various vocational schools established through the co-operation of the manufacturers of welding gases and equipment, and likewise the schools maintained by the unions in various sections of the country are doing good work, and considerable headway has been made. Many engineers express a willingness to specify the oxy-acetylene welded installation provided they can be assured that reliable contractors will be available to do the work. As a rule, the architect is willing to approve welding if the contractor wishes to use this method and stand behind it. The next year should see a decided advance in the use of pipe welding in low pressure heating installations. A general reduction in wall thicknesses of pipe, made feasible when the piping is welded, should make the welded installation a decided improvement from many angles over the present method.

U. S. Naval Garbage Lighter to Be 100% Welded

The accompanying photographs were taken a short time ago during the ceremonies of the laying of the keel of what is to be the U. S. navy's first all-welded self-propelled ship-shape vessel. This boat, which is to be a garbage lighter for servicing the Navy's battleship fleet in San Pedro Harbor, will have a length of 118 feet by about 26 feet in width, and

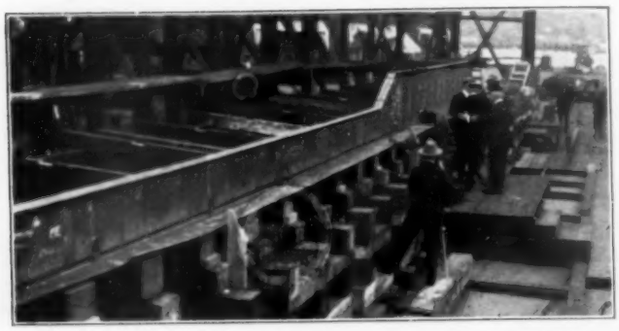


Figure 1. Part of the Keel of the Naval Garbage Lighter.

will have a displacement of 155 tons. Launching of this boat is expected to take place about June first.

The plate used in the boat's construction will be ¼-inch with the use of continuous welds, of course, for water tightness. In the construction of the boat much experimenting will be done for information and other valuable data to be used in future ship construction. Tests and experiments will be made with intermittent welds, chain welds, stagger welds, and lap welds. Lap joint welding will be employed on shell plates. Ends of plates are to be connected by lap joints.

This 100 per cent-welded craft will be Diesel engine propelled, and will have a speed of approximately seven knots per hour. The welding will be practically all by electric arc, and specifications call for the use of nothing but bare rods throughout.

Figure 1 shows a section of the keel on the building ways ready for construction to proceed. Navy officials and representatives of the American Welding Society who were invited to attend the ceremony of laying the keel of the welded craft are seen in the picture. Figure 2 shows Lieut. Commander Wallin making the first weld on the keel.

Figure 2. Lieutenant Commander Wallin Making the First Weld.

Those in charge of the construction of the boat include Lt. H. A. Schade, Assistant Shipbuilding Superintendent, and R. W. Clinkscale, Quarterman Welder, welding foreman.

What the X-Ray Can Do for Industry

By Wm. G. Praed,
Radiographic Engineer, Claud S. Gordon Company

Surprising results have been brought about by the coupling of good shop knowledge with the Radiograph, showing trained minds which way out, not depending on what any particular man decides without this sight knowledge. We have all seen men who are masters in their field examine a piece, first turning it this way, then that way, upside down, peering into it if possible, and we wonder what they see at every turn. Think what a help this actual sight knowledge means to a group of men industry is depending on for right decisions, and how much can actually be saved with this chance to start right.

1. What does it mean for the metallurgist to delve into the treatment of a piece of steel having a known chemical analysis?

2. Will the steel give the results expected from his prescription?

3. Can he tell today whether the atoms are in preferred or random orientation?

The answers are, first it takes a long time and is a tedious process to not only analyze the steel but prescribe its treatment.

Second, the results will be only fairly accurate. To get the most and best out of a steel today it is necessary to make X-ray diffraction patterns.

Third, the metallurgist cannot tell whether or not the atoms are in a preferred or random orientation, because while for practical use they may magnify as high as 1000 times he still will not be sure of their findings. With the X-ray diffraction method the magnification is approximately 1,000,000 times, making it very much easier without taking anywhere near the time, plus giving answers to problems found in no other known way.

The study of crystalline structure by the X-ray method will assist the metallurgist in controlling the quality and quantity of work no matter what it is. There is nothing like seeing through a casting to convince the Superintendent that the molder has started wrong, and to realize the effect of misplaced gates and risers, out of line cores, damp molds and numerous other diseases to which casting is subject, practically all of which can be eliminated.

The same may be said of the other branches of the metal field—for instance the Drop Forger or the Welder. In drop-forging what a help radiographs are to the man responsible for the quality of the work. What a help it is to him to be able to tell the flow of different heats, to be sure of the freedom from impurities and segregations. The assurance that he is starting right means that he can meet competition with a fuller understanding of what he is doing and better known results.

In the West recently over 350 welders were examined for building construction and out of that number only 24 qualified. Think what this will mean to industry, also what it means to the welders themselves, for no man will want to be thrown out of employment because he cannot qualify. With the adoption of welding codes what a scramble there will be for expert welders, and manufacturers will have all their welders trained for qualification, which will be done periodically by X-raying. Their work will be X-rayed, and, with competition keen, manufacturers are going to watch results carefully to avoid doing work over two or three times. Heretofore we could not blame inspectors for they passed only what they thought was right and no one questioned them. Today a new era is dawning in the welding field, and with some progressive manufacturers taking advantage of the situation it looks as if the use of the X-ray laboratory will be common practice in the near future.

In this brief discussion we have barely touched on only three fields of the metal industry, foundry, drop-forging, and welding. We have not even scratched the surface. Consider how many other branches there are of the metal trades, not to mention the other fields of endeavor that can be helped by the use of X-ray.

Some Resistance Welding Problems*

Factors to Be Considered and Coordinated—The Problem of Welding Dissimilar Metals—How Balanced Conditions Are Obtained

By C. L. Pfeiffer†

In Two Parts—Part One

PRACTICALLY all metals or combinations of metals may be joined by the resistance welding process. Welding means actual fusing together of the parts being joined. Very often a joint is called a weld when it is only a mechanical union produced on a welding machine. Joints of this type may be satisfactory for a specific purpose, but care should be exercised to distinguish between a mechanical joint and a true weld.

Joints made by the resistance welding process may be grouped under three general headings: butt, spot, and hybrid joints. These are shown in Fig. 1, and are listed as "A," "B," and "C," respectively. "P"$_1$ and "P"$_2$ are the parts to be welded, "J" indicates the joint. In a butt welded joint, round or rectangular rods, P_1 and P_2 are gripped between welding jaws and the extending ends fused together. In a spot welded joint, two or more sheets, P_1 and P_2 are held together by two electrodes and fused locally between the electrodes. In the hybrid joint shown at "C," Fig. 1, P_2 is backed by a spot welding electrode, and P_1 is gripped by a butt welding electrode. The hybrid joint is the most difficult of the three and should be avoided if possible. In all three types of joints, each pair of electrodes usually includes a stationary and a movable member.

The following list indicates the factors to be considered and coordinated when attempting a resistance welded joint.

1. Current density per unit area.
2. Time of current cycle.
3. Pressure per unit area.
4. Electrical conductivity of the parts being welded.
5. Heat conductivity of the parts being welded.
6. Specific heat of the parts being welded.
7. Melting points of the materials.
8. Medium in which joint is to be made.
9. Cooling stresses.
10. Heat of fusion.
11. Contact resistance.

The elements usually considered in resistance welding are current, pressure, and time. The function of the current is simply to bring the points to be joined to the proper fusing temperature. The resistance of the path through which the current flows multiplied by the square of the current and the time of application in seconds gives the total energy input. As the parts heat up the resistance of the material increases, tending to decrease the current. However, a better contact is usually made as the weld progresses so that the original contact resistance is reduced. If the parts to be joined are made of the same material and are arranged in a symmetrical manner, similar to that used in a butt or spot weld, both parts will reach a welding heat at the same time. When this plastic stage is attained it is simply a matter of applying the proper pressure to insure a good joint.

If, however, either unlike materials or like materials are to be fused into a hybrid joint, or unlike materials are to be fused into a butt or spot welded joint, then the electrical and heat conductivity, the specific heat, the melting point, and heat of fusion of each material used should be taken into account. The problem resolves itself into the establishment of heat balances as the parts must both reach a temperature where they will readily fuse or alloy with each other simultaneously.

The exact heat balance can usually be determined experimentally. The metals to be joined have certain properties which indicate the proper procedure to provide an approximate balance. For instance, in butt welding dissimilar metals, the one having the higher melting point is allowed to project from the jaws farther than the other. That metal having a higher heat conductivity or a higher electrical conductivity is usually also allowed to project farthest.

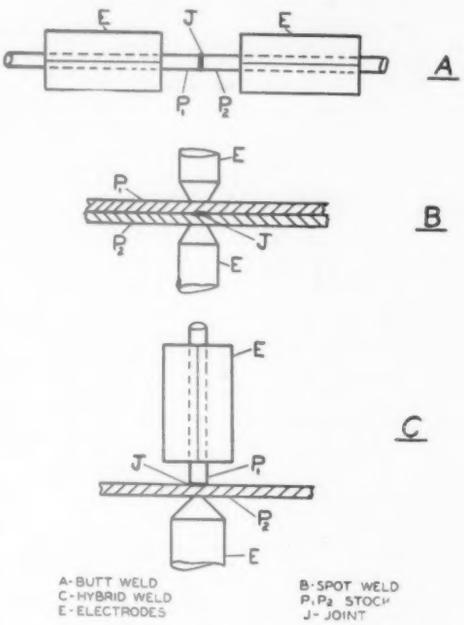


Figure 1. Types of Welded Joints.

These properties may at times have a compensating action in opposing each other, which is, however, seldom the case. For instance, copper and aluminum have relatively higher electrical and heat conductivities, higher specific heats and higher melting points than tin and nickel silver.

In spot welding dissimilar sheets a heat balance may be procured by varying the size of electrode tips or the electrode material. If copper electrodes are used a much greater amount of heat is conducted from the weld area by an electrode having a larger surface contact than one having a small surface contact. Similarly the electrode having a larger bulk behind its contact surface tends to draw heat from the point of contact. In order to concentrate heat applications, small electrode surfaces and electrode materials having lower heat conductivities and higher melting points than copper are used. For example, in welding a sheet of copper to a sheet of iron the use of a tungsten electrode against the copper and a copper electrode against the iron is recommended.

In making miscellaneously shaped hybrid joints each case

*Abstract of a Paper read at the Annual Meeting, A. W. S., New York City, April 22-24, 1931.

†Engineer in Charge of Welding Development, Western Electric Co., Hawthorne Plant.

should be closely analyzed. It is quite obvious that in a joint similar to "C" in Fig. 1, part P_1 will tend to become hotter than P_2. One remedy for this unbalance is the use of a small contact area on the electrode against P_2 and arranging P_1 to project only a small amount from a large contact surface electrode. Furthermore, in choosing materials it will be advantageous for P_1 to have either a higher melting point, higher electrical conductivity, higher heat conductivity, higher specific heat, or higher heat of fusion. It is possible, of course, to overstep the balance point and have even the larger part of P_2 get hotter than P_1. Such a condition would be rare, however. Each case is usually resolved into a choice of doing only one of several things to bring the parts to be fused to the proper welding temperature at the proper time.

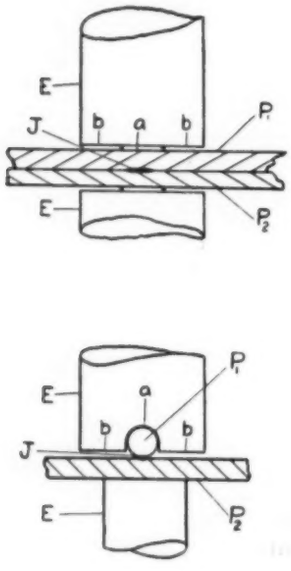


Figure 2. Special Electrodes.

P1P2 - STOCK E - ELECTRODES
J - JOINT
A-B - ELECTRODE CONTACT SURFACES

Although the pressure on the movable electrode usually serves to force the plastic parts together, there are other functions this movement may cover. The initial contact pressure determines the amount of contact resistance and consequently limits the first rush of current. The initial pressure may also determine the amount of contact surface and thereby determine the current density at the point of contact. It is very difficult to distribute pressure equally over irregular surfaces or along the edges of wide thin sheets in butt welding operations. It follows that joints having an unequal pressure distribution should be avoided, since this causes variations in current densities per unit area and consequently produces an irregular and poorly fused joint.

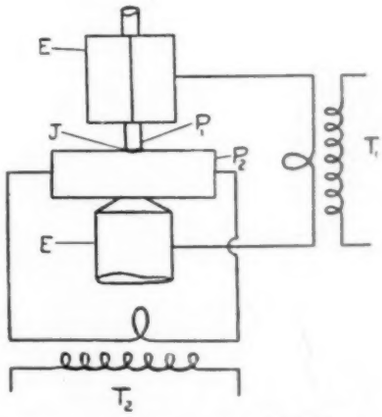
The pressure on the movable jaw also determines the acceleration of this member after the parts become plastic. This is very important when high conductivity metals are being welded. In these cases a very high current is sent through the parts for a short time. If the parts are not free to move together quickly an arc blowout is produced, in which case either no joint or a very poor joint may result.

In many cases it is very important to have a nearly constant current. This is especially true when attempting difficult joints. An approximately constant current may be obtained by introducing a resistance or reactance ballast into the welding circuit. For light work a metallic shunt around the electrodes or immersion in a liquid will serve as ballast. Ballast not only tends to stabilize the current, but it is an effective means of dealing with variable contact resistances.

The design of electrodes is very important. Both the material and shape of the electrodes should be analyzed carefully. The most generally used materials are copper, tungsten, or alloys of copper and tungsten. Copper can be used in practically every case. Where wear is heavy it may be well to substitute harder alloys of copper and tungsten. These, however, become hotter than copper and are generally cooled by water chambers, air, or radiating wings. The tip contact area of the electrode determines the current density for spot welding operations. The current density may be varied during the welding cycle by electrodes shaped like those in Fig. 2. Part "a" makes contact at the beginning of the welding cycle, but after the parts compress and start to fuse, surfaces "b" make contact, thereby cutting down the current density below the welding requirement. This acts as an automatic stop at a critical point of the operation. Such electrodes are similar in action to projection welding methods, where a part of the material to be joined is embossed in order to localize the heat. As soon as the projection fuses into the part being welded the current density is greatly lowered, this action being similar to a current cut-off.

Sometimes the parts being joined have such dissimilar characteristics that it is impossible to provide the proper heat balance by changing material or modifying electrode shapes. In some such cases it is possible to preheat the part which tends to remain cooler by means of a separate transformer. Fig. 3 illustrates an extreme case of this kind. P_2 is either very large or has a high heat conductivity. The circuit is usually arranged so that part P_2 is brought to a near welding heat by current from transformer T_2. At the instant that current from T_2 is cut off the welding current from T_1 is cut in. This insures perfect fusion if the current values and time of application are properly coordinated.

The use of more than one transformer per welding machine is closely related to the use of multiple electrodes. A number of simultaneous welds may be made by one transformer if the type of joint is simple and the material welds readily. If, however, the welding operation is at all critical it is advisable to provide one transformer for each joint.



P1P2 - STOCK E - ELECTRODES
J - JOINT T1 - WELDING TRANSFORMER
T2 PRE-HEATING TRANSFORMER

Figure 3. Welding Circuit with Preheating Transformer.

In such cases separate mechanical action should be provided for each electrode or the purpose of having separate transformers will be defeated. One transformer may provide current for more than one weld if the joints are arranged in a series set-up. In such cases the nature of the joint or the electrodes must be such that on the completion of the weld the current density is automatically decreased. This takes care of any irregularity in the time necessary to complete a good joint.

Although most metals join readily, some are more or less

obstinate in their resistance to this operation. This may be illustrated by two hands. For example, the intertwining of fingers is similar to perfect fusion between the parts being welded and provides a satisfactory joint, usually as strong as the adjacent material. The two hands pushed against each other, fingers curved back, indicates the kind of joint often produced when the parts have no natural affinity for each other. Some of the permalloys, high carbon steels, chromium alloys, cobalt steels, and silicon steels may be classed as metals tending toward the latter type of joint. A test for fusibility is the welding of identically shaped parts under varying conditions of balance. If a poor joint results consistently, special accommodations are usually required. For instance, in butt welding a certain permalloy wire, a

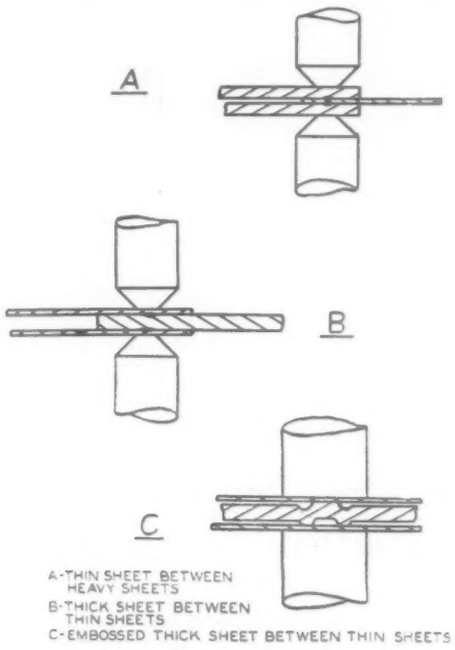


Figure 4. Spot Welding More Than Two Sheets.

brittle, weak joint resulted. When immersed under carbon tetrachloride the joint became strong and tough, so that the wire could be reduced by drawing through dies without failure. This seemed to indicate that the liquid acted similar to a catalytic agent. A more thorough search into this matter should prove interesting.

Development of a rapid non-destructive method of testing resistance welds will eliminate a certain amount of uncertainty now prevalent in welding processes. This is especially true of non-ferrous joints where the welded parts must be very strong. The usual tests are destructive in nature. If the part fails at a point outside of the welded area, the joint is considered good. However, this test cannot be applied to parts that are to be used. A tension, compression, or shear test of a value slightly less than the average point of failure may weaken an otherwise good joint. If the force applied is relatively small, the test is of small value. A destructive test applied to a small percentage of the parts is the best method now available. If the parts are being welded on an automatic machine a mechanism may be included to test every tenth, hundredth, or thousandth joint to a value approximately failure, but not destructive. All of the tested parts should be segregated and treated as seconds and approximately ten per cent given a destructive test. If these results are consistent they provide a fairly reliable measure of quality for the entire production. The number of parts to be tested depends on the simplicity of the welding operation. Shapes and materials which are easily welded require less inspection than those which are difficult to join.

A frequent problem is the spot welding of more than two sheets of either like or unlike materials. Fig. 4 gives some general examples of these joints. "A" shows a thin sheet between thick members and "B" shows a thick sheet between thin parts. For the same material type "A" welds are simpler to make than type "B." The inside sheets heat up less rapidly because the current density is usually less. If, however, the center piece in "B" has a lower melting point, a lower heat conductivity, or a lower electrical conductivity than the outside pieces, the condition of balance facilitates production of a perfect joint. If, on the other hand, the center piece in "B" has a relatively higher melting point and higher heat and electrical conductivities the problem is very difficult. In this case it may be possible to localize the heat by using a high current density for a very short period. Other possibilities are the introduction of pellets, or a double circular embossing as shown in "C" of Fig. 4. In this type of joint the surface contact area of the upper and lower part of the embossing must be approximately equal.

The welding of plated parts is closely related to the spot welding of multiple sheets. A plated sheet really consists of the sheet material itself and two thin layers of the plating material on each face. "A" in Fig. 5 illustrates this condition, P_2 being the plated part. Closely balanced spot welds usually produce good joints under these conditions. Some trouble is presented by chromium plated parts because of the high melting point of chromium. The use of plated parts of dissimilar materials or hybrid joints of either similar or dissimilar materials usually increases the difficulties of welding plated parts materially. Irregularities in shape or differences in material characteristics may sometimes be used to great advantage. For instance, in spot welding platinum to a chromium plated part, the high melting point of chromium is advantageous. On the other hand, if the plated part

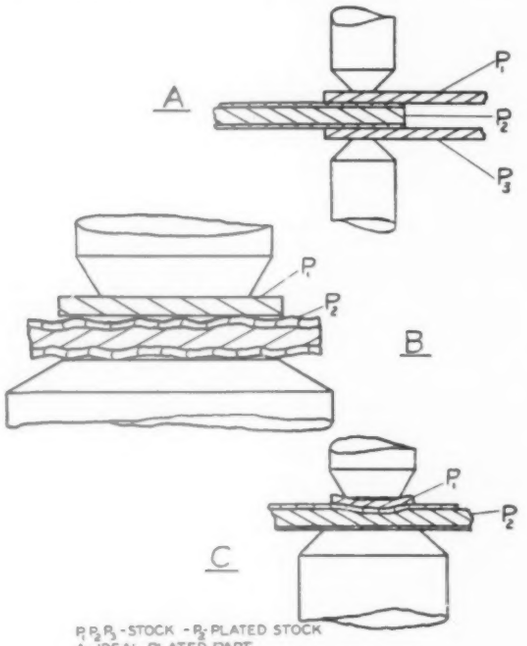


Figure 5. Spot Welding Plated Parts.

has a very large bulk in comparison to the part to be welded to it, the use of a low melting point zinc plate is helpful. Plated parts as a rule are less apt to be smooth than unplated parts. In order to lessen welding difficulties, special care should be taken in cleaning parts, in developing smooth surfaces, and in controlling plating methods. Fig. 5 illustrates some difficulties encountered in welding to chromium plated parts. "B" shows the surface irregularities of a chromium

plated silicon steel armature. In spot welding previous metal discs to these armatures, the points of contact produce different current densities for practically every weld. "C" indicates how the chromium plate remains intact after all other parts become plastic during the welding cycle. In some instances parts may be welded before plating. This may, however, introduce another difficulty, as minute crevices or irregularities in the welded area often accumulate plating salts which later emerge to discolor and corrode the parts.

Four important considerations in the design of welded apparatus assemblies may be listed as follows:

1. Type of joint.
2. Choice of material.
3. Shape at the point of welding.
4. Accessibility of electrodes.

These things have previously been discussed, but a brief repetition may emphasize their importance.

In choosing the type of joint every effort should be made to provide a perfectly balanced spot or butt weld. This will usually simplify every subsequent consideration, the most important of which is a choice of material. If it is necessary to use a hybrid joint care should be exercised to avoid extremes.

The most universally used materials for welding are iron and steel, although other materials are used extensively and successfully. The following tabulation lists the more generally used materials in the approximate order of their weldability:

1. Wrought Iron.
2. Low Carbon Steels.
3. Nickel.
4. Nickel Silvers.
5. Monel.
6. Bronze.
7. Galvanized Iron.
8. Permalloy.
9. High Carbon, Silicon, Cobalt, or Chromium Steels.
10. Duralumin.
11. Nichrome or Chromel.
12. Aluminum.
13. Copper.
14. Brass.
15. Zinc.
16. Lead.

The first consideration is the fusibility of the material. This is most easily determined by experimental butt or spot welds. For welds which join dissimilar materials or are hybrid in nature, a close inspection should be made of the heat and electrical conductivities and the melting points. A study of these characteristics will help one establish at least a near heat balance so that opportunities for perfect fusion are greatest.

Some materials have peculiar cooling characteristics after being subjected to the welding operation. Stresses may be set up which fatigue the joint, and although an immediate test shows the weld to be strong, tests made months later may demonstrate material weakening.

Shapes of the parts being welded and accessibility of the electrodes are closely related in welded apparatus design. The shape of the parts determines the type of weld to be employed which should be such that the joining process makes possible an easy heat balance. In order not to hamper production the electrodes must be made easily accessible to the point of fusion, even if this makes a heat balance more difficult. The parts and the welding fixtures should be designed so that the electrodes may be easily trimmed or replaced, and, if possible, to permit the use of standard designs.

In all welding operations the presence of grease, dirt, scale, or other foreign material causes trouble. Parts should be designed so that they may be dipped in cleaning solutions, tumbled, or sand blasted. This promotes constant factors in the welding operation and consequently speeds up production.

(To be concluded)

Rivets or Welds*

By Lee H. Miller†

IT WILL be noted that I have changed two letters in the title to the paper as assigned me by your President. Rivets vs. Welds suggests a combat in which one or the other will be eliminated, while one alone survives. It is my conviction that we will always have both processes of connecting steel parts and it is the problem of the engineer or architect, who wishes to keep abreast of the moving times, to keep himself so informed that he can, with confidence, tell his clients where and how either rivets or welds can be used.

Based upon my present experience and information, I consider it folly to claim we are now ready to abandon rivets, since welds can be made to replace them, and it is as great a folly to wipe welds from our industrial processes, because we lack the experience to inspect and analyze their properties.

The exponent of welds obviously to me overstates his case in some of the claims that he makes. Such exaggerated statements impede the progress of the art, since they often close the mind of engineers, who recognize the exaggeration and as a result discard the whole subject until such time as it is presented without the virtues being entangled in chaff.

The competent structural engineer is gifted with an instinct or sixth sense of balanced structural proportions into which is woven a background of experience and technical training that co-ordinates the three essential elements. He cannot be stampeded into a position where his sixth sense, his experience or his technical training are not satisfied. He not only checks and double checks, but he triple checks, and furthermore, he does each in an established sequence.

Rivets have been his companions and almost his bed-fellows for the years of his experience, and the experiences of generations before him. They have been so constantly a part of all his work that much needed research on their process of functioning has not received the consideration merited. Like a broken-in shoe they almost automatically adjust themselves to meet the stresses occasioned by service.

It is one of the properties of stress to follow the line of greatest resistance or strain, and the remarkable faculty of steel to carry a local stress beyond its yield point, where its immeasurable plastic movement brings an entire connection into service with an increased yield point due to cold working.

A properly designed group of rivets for a connection will by this process under a service load adjust themselves to an approximately uniform condition in spite of minor variations in workmanship. Consciously or unconsciously the experienced engineer reacts to this characteristic of a riveted connection and may be unwilling to abandon it for welds, and his more or less limited experience as to this action.

Where Rivets Have Failed

Steel structures have failed under different conditions as to cause but I have been unable to identify any structural failure resulting from rivets or where rivets have failed in service. Rivets have, however, failed in driving, either as a result of excessive heating for manufacturing the rivet, or for driving them. It is known that too high a temperature seriously injures the metallurgical structure of the steel and that once subjected to this high heat only by expensive treatment can the material be reconstructed.

It must be recognized that with all the years' experience and use in rivets they are not foolproof, and there has not been the amount of research and there does not exist the

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as widely distributed data as the importance of rivets merits. In fact it has been stated that in the last five years there has been more research on welding and more data published on welding than there has been on rivets in the last fifty years or more.

With as broad a background of experience on welds as the engineer has on rivets he would find many places where economy and safety are satisfied by welding. It is easy with satisfactory existing methods to assume a "show me" attitude towards welds, believing that when the other fellow has developed his experience it can be acquired and put on with no more delay than changing a pair of shoes. This is unfortunately not true and there are many places of secondary nature where welds can be used and experience acquired without involving the primary parts of the structure. Take for instance the case of steel plate floors, which do not involve the main frame, there is an opportunity to use many times the amount of welding that the main frame would require. The problems of welding a structural frame differ from those involved in welding smaller units where by careful research it is possible to establish procedure and sequence for exactly duplicated conditions, and produce satisfactory results. In a structural frame the various connections are not duplicated and are related to each other in a manner that as yet is hard to control.

The Metallurgy of Poor Welds

Electric arc welding involves conditions resembling foundry castings, except that the liquid metal is in much smaller units and is not poured from a ladle. It differs from the chilled casting of the foundry in that the electric arc by its action heats part of the parent metal. It permits the experienced or careless welder to produce a result in the metallurgical structure similar to that occurring in burned or overheated rivets. It involves cooling strains and shrinkage similar to foundry work where the pattern maker must use a special scale of measurements amounting to approximately 3/16 inch per foot.

An examination of these conditions does not mean they cannot be successfully met just as they have been in foundry work, and it is possible that the welders will attain a closer approximation to perfection than the founders and in fewer years of research.

In connection with the large welded skeleton frame office building in Dallas, Texas, more than 100 supposedly competent welders tried to qualify for this work and only 10 were accepted for shop work, and half of these, or five, for field work. This looks like a high mortality rate, but perhaps if as rigid test were applied to riveters many would also fail. The firm constructing this building acquired valuable experience under the supervision of consulting engineers representing the owners and they assure me that under similar conditions they would be glad to do similar construction, but they have no intention of scrapping their riveting equipment.

Welds in Thick Sections

Welding has made possible the manufacture of equipment that has been of great economic value to industries. Large pressure vessels eight feet or more in diameter carrying pressures of more than 1,000 lb. per square inch at temperatures over 1,000° F. have been welded of steel plates from 4 inches to 6 inches in thickness. Axial seams and dished heads have been butt welded by depositing layer upon layer of arc weld metal to build up the full strength of the heavy walls of the vessels. The wall thickness of many of these vessels is beyond that in which riveting has ever been undertaken. It has been found that a single deposited line forming a fillet bead has a coarse uneven structure but as the succeeding layers are deposited there is constantly increased refinement of the metal previously deposited. This condition is particular conspicuous in the texture of the fracture which shows the various stages in refinement of the built up metal.

The relation of the engineer to rivets and welds is that of designing, inspecting and reporting to the purchaser whether the work is in accord with the conditions of the purchaser's contract. The relation of the manufacture of single unit articles is that of designing, workmanship, inspection and guaranteeing the purchaser that all is done in accordance to a specification acceptable to the purchaser.

The relation of a manufacturer or fabricator of a structure is that of providing material and workmanship in accordance with an engineering specification, and to the satisfaction of an engineer of inspection representing the purchaser. It is apparent that engineers and inspectors are going to prefer the type of connection that they best understand, and feel most competent to report to the purchaser regarding workmanship. The routine of rivet inspection has a background of procedure that has met industrial and technical requirements over a long period of time and the non-destructive test or inspection of welds is relatively little understood. Until this talent is more widely distributed the conservative engineer adheres to rivets, but he can contribute to the distribution of knowledge on welds by employing them for secondary parts of the structure where the functions of the main frame are not involved.

The Commissioner's Position

The relation of the Building Official to rivets and welds is quite different from the others mentioned in that he must administer enacted public safety ordinances and participate or recommend the revisions of such ordinances to meet advancing conditions, but always remembering that he must administer the revisions. He must deal with the talented and the ignorant since both are his public. To whatever extent he varies from the written code he becomes personally involved. It is not the function of the Building Commissioner to guarantee an individual that his building is constructed in accordance with a purchase contract, but it is his function to protect the public against individuals constructing buildings in violation of enacted safety codes. The Commissioner is naturally opposed to codes that are impossible or difficult to enforce with the inspection forces under his direction. He hesitates to approve what the engineering profession have failed to recognize, and are competent to design, supervise and inspect.

It is my opinion that welds should be permitted for secondary parts of structures which do not involve the primary stresses of the skeleton frame and for primary stresses for the present when the owner assumes the responsibility for proper design, material and workmanship. To advance the welding art and insure safety such primary welded construction should be designed and supervised by a competent committee approved by the commissioner and the records of their experiences and recommendation should become available to the commissioner and the engineering profession.

New Type of Metal Window Is All Welded

The Truscon Steel Company, Youngstown, Ohio, has recently announced a new type of all-metal window called the Model 31-HR. This is a double hung window with a heating recess and is described as a complete unit of window and heating recess encased in a rigid steel frame with all joints welded. The width and height can be varied to suit the architectural treatment and room dimensions. Width and depth of the heating recess can also be varied to accommodate standard makes of concealed radiators. The outlets from the heating recess may be through the window stool, through the front panel or both, and the front of the heating recess offers a choice of materials and design. The complete unit may be placed and anchored in position immediately after the structural concrete is cured.

Gas Welding Used to Install Extensive Pipe System

Welded service piping for the handling of steam, water and oil on a big scale, is one of the features of Chicago's new sewage treatment plant. This plant, several units of which are in operation, will when completed take care of the sewage disposal problems of an area having a population of 1½ million people. The plant is located at 39th St. and

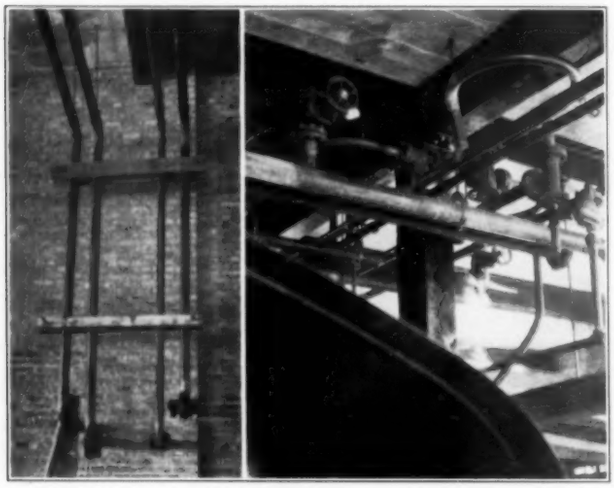

Figure 1. (Left) Where Welding Is Used Pipe Can Be Fitted Close to the Walls. Figure 2. (Right) If Fittings Were Used This Would Be a Complicated Assembly Indeed.

52nd Ave., in Stickney, a Chicago suburb. This major engineering project has created a great deal of interest among sanitary engineers throughout the country not only because of the immense size of the plant but also because in its construction and layout the most up-to-date methods and processes are being employed.

The contract for the service piping in this plant was awarded to the Johnson Brothers Heating Co., of 1419 Belle Plain Ave., Chicago. The specifications on which bids were asked called for flanged joints. After part of the system

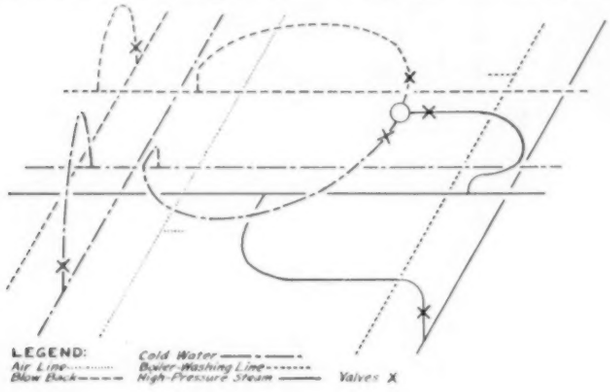

Figure 3.

was installed, the contractors decided to employ oxy-acetylene welding for fabricating some of the runs of pipe. An accurate record of costs was kept. Although this was Johnson Brothers' first attempt at installing welded piping, the results were so favorable that they employed this method generally in all the piping work remaining to be completed.

The first line laid with the welding torch was a 6-in. steam supply line leading from the power house through a tunnel about 1,800 ft. long to supply branches leading to the various control houses, locomotive terminal building, etc. A test on this line after completion showed only a single pinhole leak.

The branch lines leading from the main supply are run in Ric Wil conduit buried in the ground. A total of about 1,600 ft. of this type of conduit is used, carrying a 4-in. welded high-pressure steam line and a 2½-in. welded return line. There is also about 900 ft. of 2-in. and 1¼-in. welded leads connecting with trap discharges.

In the locomotive terminal building, air, water and steam are supplied for blowback, draining, and washing. All these various services result in a rather complicated piping layout and system of control. The construction was facilitated, however, by the use of the welding and cutting torch. Figs. 1 and 2 show views of the piping system in this building partly completed, and Fig. 3 is a diagram of part of the piping system at one of the three "stations" in this building. Each "station" is controlled independently of the other two and takes care of two locomotives.

All the fuel-oil lines for locomotive supply also have welded joints, except a flanged coupling on the suction side for cleanout, which is fitted with welded neck flanges. The heating pipes and boiler manifold in the sludge-control building are also welded.

The experience of the Johnson Brothers Heating Co. is characteristic of that of a number of other piping and heating contractors. A single welded installation is enough to make evident the inherent savings in the cutting-and-welding method of fabrication and to result in a general adoption of welded joints in the larger pipe sizes or wherever savings can be effected in the elimination of stock or special fittings.

Six Million Gallon Tank Has Welded Bottom

The steel reservoir recently completed by the Chicago Bridge & Iron Works, Chicago, Illinois, for the Rochester and Lake Ontario Water Service Corp., at Rochester, N. Y., is one of the largest steel reservoirs used for municipal service, having a diameter of 200 ft. and a capacity of six

This Huge Tank Has an All-Welded Bottom.

million gallons. This huge tank has a welded bottom which was constructed under the supervision of Mr. Harry Rowe of the above company. Under his careful supervision this job was completed so as to leave a flat bottom free from buckling. This tank is located on top of one of the highest mounds in the pinnacle range and is arranged to supply water to approximately one hundred thousand persons, in more than 110 sq. miles of the Rochester area.

A water tank of four million gallons capacity was recently erected by the same company for the city of Baltimore. This one had both all-welded bottom and a self-supporting dome of welded construction. The conventional procedure in the construction of these tanks is to lay and tack the bottom plates, then lay on the lower angle and weld before erecting the first range. The rectangular plates are then cut loose from the sketches and all welders start in the center of the bottom and work toward the sketch plates in circles, attaching the sketch plates after all rectangular plates are welded. The bottom is usually tested for tightness by forcing water underneath the plates through the nipples welded to the plates at about 20 ft. centers over the entire bottom. Thirty pounds pressure is considered sufficient to insure an adequate test.

Welding In a Process Industry*

Paper and Pulp Mills Provide Opportunities for Applications of Pipe Welding, Plate Work, Repair Welding, and Special Fabrications

By H. R. H Young†

THE pulp and paper industry is made up of a number of processes, both mechanical and chemical, where the raw products, spruce, hemlock, fir and cedar, as well as a few of the lesser used woods are processed to various grades and types of pulps. These pulps are refined, screened and blended together under various formulas, with sizes and clays, to be manufactured into the finished product, paper, on fast running paper machines. Three types of welding are used extensively in the industry; oxy-acetylene welding, electric arc welding and lead burning.

Piping for 28,000,000 Gallons of Water Daily

The pulp and paper plant uses large volumes of water in converting the raw product to the finished article, be it paper towels, newsprint or milk bottles. For every pound of paper manufactured in a plant, there are same 35 gallons of water used somewhere in the conversion system. If a modern, up-to-the-minute plant were to manufacture 400 tons of paper every 24 hours there would be required 28,000,000 gallons of water flowing through the pipes for the same period of time. This does not include any water used for water power development, but is that which is essential to wash and screen the pulp and furnish a means of transportation to various departments. Pressures up to 300 pounds to the square inch are used in showers and wash lines to promote modern and efficient conversion. Imagine the network of pipes which are necessary to make up this system. Welded pipes, flanged and bolted or continuous butt welded lines are very common in the mills. In our piping system there are many side feeders and by-passes which are necessary in the blending of various grades of paper, and it would be a long and tedious job if all these connections had to be made up from stock tees and elbows, 45° ell's and a multitude of dutchmen. If all the pipe changes in a paper mill were made with screwed, flanged fittings, it would be necessary to triple the crew of maintenance pipe fitters and I doubt if the paper machine would be ready to start Monday morning after a Sunday shutdown. A great saving has been made in replacing 45° and 90° elbows on large welded pipe lines, which wear away in half the lifetime of the straight lengths, due to excessive abrasion and corrosion. The elbows are made up of welded segments with a reduced diameter at one end and an expanded diameter at the other. These new sections are slipped into the place of the worn fittings, which have been removed with a cutting torch, and are then welded either by arc or torch welding. This saves an expenditure for a new section of pipe. Oxy-acetylene welding is very useful in patch jobs in piping, and is a great help in fast replacements.

Many of our worn valves would have to be discarded long before their life was over if they were not reseated by welding. In some cases we build up the valve seats with a torch and reface them in the lathe; while on large valves the old seat is machined away and a new seat welded into place. In this case spending $5 or $10 on welding and machining saves the cost of a new expensive valve.

Considerable trouble was experienced on a large butt welded water main carrying water of slight acidity. Trouble from small welding failures was experienced from time to time. It was found that various types of welding rods had been used on this job and it was the opinion that dissimilar metals exposed to the acid solution set up destructive electrolytic action. Ultimately the line was rewelded and some of the trouble alleviated.

Large welded water mains are often a source of trouble due to the ground sagging if the line is carried over ground having new cuts and fills. Expansion joints are very necessary to take up the sagging of the long spans. A single bellows joint has proven very satisfactory. These joints were made up in one plant by separating the two pipe lengths to be welded by a 1½" space between the pipe ends. Two large circular flanges of flexible metal were welded to the ends of the pipes. The outer edges of the flanges were then drawn together and bolted with a gasket between the flange faces. Some expansion joints were drawn together with clamps and then welded. Either of these methods makes a very cheap and satisfactory expansion joint for low pressure work.

Welded Steam Lines

Steam lines are being made up of butt welded lengths of heavy pipe. In one plant there was a hundred and fifty pound steam line, 12" in diameter, erected 14 years ago and it has never been touched. This steam line was tested by the underwriters at that time, and they were unable to find any trace of a faulty joint or leak in the entire line of some 500 feet.

There are two 12" high-pressure steam lines (three to five hundred pounds to the square inch) which run side by side in a pulp mill. One is made up of torch welded joints, and the other is screw flanged and bolted. The welded line is a continuous white insulated installation without a water stain on it. The other line has ugly flanges every twenty feet and drops of hot water were always falling down the operator's neck during a shutdown. The cause of this was leaky flanges. A welder has had to go over the entire line and weld the flanges to the pipe. This trouble was caused by a poor contractor handling the job, but it would have never occurred if the work had been a butt welded specification. The cost of the gasket will almost pay for the welder's time and material, and you have the flanges, bolts and piper's time to the good, to say nothing of the appearance of the finished job, which is quite a factor in these days of competition.

Steam headers which supply the drying section of a paper machine have been greatly simplified since torch welding has been developed. The back side of the dryers has some fifty or sixty steam connections from the supply header and the same number to the return header, which handles the condensate. These headers were formerly made up from a quantity of nipples and tees. This is costly construction and difficult to keep tight, due to the expansion and contraction from weekly shutdown. Present practice is to weld the feeder connections into the main header pipe, which makes a strong, rugged supply header free of maintenance and a safer installation.

Arc Welding Applications

An electric arc unit is very useful around a pulp and paper plant and pays for itself very quickly. A water line in a paper mill which was supported under some concrete

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beams, cracked one-third the way around its periphery due to poor supports. It was necessary to keep this main open as three paper machines were depending upon it for their water supply. An electric welding generator was rolled into place, a ¼" rod used, and the machine was set up to 400 amps. The operator started welding on the dry side of the pipe and worked around the circumference, completely welding the leak. At no time was the water in the pipe turned off.

A welded ⅜" steel plate flume 2,300 feet long was built to convey wood blocks from the saw mill to the chipper room. This was supported by welded channels and angles set in concrete footings. This job was completed in three quarters the time which would have been required for a riveted seam.

Special Construction Pays Its Way

One arc welded job which deserves comment was the construction of water cooled arches and side walls in the recovery furnaces of a sulphate mill. In the sulphate process, the alkali digesting reagent used to remove the lignin, or waste material, from the cellulose in the wood, is recovered from the cooked wood. This is necessarily due to the expensive chemicals used. The weakened chemicals which have become polluted with tannins and resins from the wood are thickened in surface evaporators, from three degrees Baumé to about thirty degrees Baumé. The mixture is then burned in a recovery furnace which ignites the waste materials and the desired sodium sulphide is drained from the base of the furnace. The temperature in the furnaces range from 2,000 to 2,500 degrees F. A thick layer of soapstone or magnesium silicate masonry is used to withstand these high temperatures along with the active alkali gases. It is very difficult to keep this masonry in repair. A false water cooled arch was made up of half-inch steel plate. The false arch has a thickness of 8 in. and is curved on an 8-ft. radius. It is four feet wide and covers the upper half of the periphery of the arch. The plates were butt welded using a ¼" rod and stay-bolted at regular intervals. Two side wings were made up of the same construction, and hung on the upper side walls where the heat was most destructive. This installation furnished a good masonry protective shell, as well as supplying a large part of the plant with hot water. Water cooled arches are by no means a new angle, but to build these false walls with the regular mill maintenance equipment means a good saving.

In the evaporator department of a sulphate mill, the bottom shell casting of a large evaporator collapsed. This was a vital part of the plant's equipment and had to be replaced, or a shutdown and decreased production was inevitable. The base of this evaporator was a cast iron shell, 9 ft. in diameter and 5 ft. high, an inch and a half in thickness, with several large manholes and sight-ports. It would require six weeks to receive a replacement from the East. Permission was obtained from the underwriters to install a welded section, if it would stand the vacuum inspection test. The shell was rolled from half-inch sheet steel plate and shipped to the mill. Three welders worked on the job making a double lap welded joint, and erected a complete built-up replacement of the evaporator base. The work was completed eight days after the accident. The cost of the repair was equivalent to the cost of the casting in the East. The freight charges and long period of reduced operation was saved. This shows one of the many ways in which the art of welding has fattened the pocketbook of the manufacturer.

Salvaging Intricate Castings

In a paper mill we have a great deal of equipment made up of solid heavy castings with journals cast as an integral part of the casting, such as dryer heads on the paper machines. When the journals become worn due to lack of lubrication or bearing failure, they become quite costly if they have to be replaced. Oxy-acetylene and arc welding have played a large part in reducing these maintenance costs. The journals are built up and are turned down in the lathe to their original diameter, making a practically new unit. This practice has proven cheaper and more satisfactory than turning the journals down and shrinking on a new sleeve.

Large steel grinder shafts used in groundwood mills are built up by welding. These shafts are coupled together, driven by water wheels or induction motors, and support large grinder stones rotating at 250 RPM, which manufacture the groundwood or mechanical pulp. Due to the acidity of the wood used, the shafts are slowly eaten away by this destructive acid. Rather than discard them, they are built up and rethreaded and put back into use.

One set up, which an enterprising master mechanic built to reduce the cost of building up shafts, was to couple a discarded air drill to a worn out worm gear. He made a coupling to connect the shaft, which needed repair, to the worm gear and put a foot valve control on the air line. The operator was able to rotate the shaft at any required speed and did away with an extra helper who would have been required to turn the work as the welding progressed. Adjustable bearings were made to handle various sizes of shafts.

One large welding job I saw completed was on a 10' steel beater shaft, which supported a heavy cast iron drum inlaid with steel knives. It was a case of discard the entire beater roll or weld the shaft, as the shaft was an integral part of the casting and could not be removed. The shaft ends at the break were turned down to cone shapes and the two centres lined up with the shaft for welding. It required 36 hours to weld this break by the oxy-acetylene method and the beater roll was put back into service.

In remote parts of the country, where paper mills are usually located, it is vital to have adequate welding facilities. Many long shutdowns would be unavoidable in Northern Canada, waiting for replacement parts to be shipped in, if they disregarded the opportunity which welding offers them.

A large main lug under a 250-ton hydraulic press was broken due to uneven distribution of the load. This casting weighed some five or six tons and would have gone to the junk pile had it not been repaired by oxy-acetylene welding.

Bronze Welding Plays a Big Part

Bronze welding is a boon to all manufacturers in keeping down repair and maintenance costs. It makes an inexpensive repair job as well as a very tough and durable one. Bronze welding adapts itself particularly to the pulp and paper industry, inasmuch as we have so many moving parts, so many bearings and brackets, which support rolls and pulleys rotating at speeds very closely to the allowed limits. Due to unforeseen accidents, the bearings, brackets and motor stands become ripped from their bases, trains of gears break, leaving shattered equipment in their wake. This does not happen very often, but occasionally a bad wreck will leave the maintenance engineer with a pile of broken castings, which a moment ago were up-to-date equipment. It is impossible to keep spare parts for every piece of machinery and when such a wreck occurs, we all bow to the welder and set him busy to make big pieces out of all the little ones. Bronze welding is popular on account of the relatively small heat which is necessary to close a break. It requires no pre-heating with outside gas flames, providing the job is not too large. A welder can repair a cracked bearing stand on a motor which is broken directly below the oil sump without removing the oil or the babbitt bearing. A careless millwright gang cracked a bearing stand when they were removing a jaw clutch from the calender stack on a paper machine. It would have taken days to obtain a new stand; a temporary pedestal would not have been rigid enough. After three hours chipping and two hours bronze welding, the bracket was as good as ever. It

was not necessary to remove the stand from the motor while welding, no lining up was made and it was surely a simple and effective solution to a nasty problem.

A large jordan used in refining pulp stock before going to the paper machines was being transferred by an over head crane. The sling supporting this piece of equipment failed and the jordan crashed to the floor. It was a solid cast iron shell construction with shell walls 2" in thickness. The intake manifold and the small end of the cone were smashed into seven or eight pieces. To look at the wreck one would say that a new jordan was needed. A resourceful master mechanic and two welders pieced the shattered shell together, chipped and flared the cracked edges, and bronze welded the casting back to its original usefulness. $90 in welding material saved a wrecked jordan from the scrap pile and prevented the expenditure of $4,000 for a new machine.

A heavy curved cast iron arm which supported a press roll on a paper machine was broken in a wreck. There were no spare parts on hand and it would require several days before replacement could be shipped in. A bronze welded job requiring 4 hours shutdown put the machine in operation. This means money when a machine shutdown amounts to $2 or $3 lost profit for every minute it is out of operation.

A boiler house breakdown caused a Corliss engine driving a paper machine to run wild, and as a result broke the supporting irons on the governor balls. These were welded in half an hour. A machinist would have taken six hours to replace them.

Tanks, Flues, Etc., Are Now Welded

All tanks, flues and breeching, etc., which were formerly fabricated with riveted joints, are now-a-days made up with smooth butt or lap welded joints, using either torch or arc welding. These installations make cheaper and quicker construction and are more pleasing to the eye. Steel stocks are made up of welded sections which are lighter and less given to corrosion and failure.

Low pressure vessels used in cooking and digesting pulp are slowly progressing away from the old riveted butt strap and lap joints. A heavy welded joint does not give the trouble of leaky rivets which have to be continuously caulked as well as replaced in digesters or cooking vessels used in the sulphate industry. Welded joints in this field have had a long, slow struggle with the underwriters, who belong to the old school of rivet fame, but they are slowly recognizing that the welded job is an adequate and economic alternative.

A well known foundry in Portland which formerly built paper machine flat screens of bolted integral castings, have discarded their patterns and are building the entire screen from welded fabrication of I-beams, channels and angles. This has resulted in a lighter, more accessible installation, a less costly piece of equipment and a stronger design.

Lead Welding

We have one type of welding in the pulp and paper industry, little used among other manufacturers, which I feel is worth while spending a few moments on. In the sulphite industry, the reactionary agent or acid used, is calcium bisulphide liquor which attacks all ferrous metals with great gusto, with the exception of some new acid resisting ferrous alloys. The only way these strong reagents may be handled is with bronze, lead or acid resisting brick. Lead pipe and lead connections will not stand up under any pressure if a threaded coupling or connection is used, due to its relative softness. Some type of fusion is necessary and lead welding is the recourse. The elbows, tees and cross connections are usually made up from lead pipe or sheet stock. The lead welder must be skilled in cutting out these grotesque and irregular shaped connections, as well as in welding them into a liquid or gas tight connection. In lead welding, an oxy-acetylene flame is used. The operator is equipped with a small torch using a very fine tip. A light blue flame is necessary to fuse the surfaces, a flame which is strong enough to fuse the metals but not burn them. Lead burns very easily and a lead welder, unless skilled, will find he has a larger hole to gap than he started with. The operator uses small diameter lead rods or strips to build up the bead. The practice used is similar to other types of welding inasmuch as he must fuse one side of the joint, work his flame across the gap, using the lead rod to build with and slowly fans the molten mound across, at the same time fusing the other side of the connection. By fanning the torch across the opening and adding sufficient lead to form a wide bead, a strong joint can be effected. This method is used in patching hard lead pump casings, gas impellers, lead cooling pipes, etc., and is an effective and economical method of lead maintenance and repair.

There are many other applications of welding in the pulp and paper industry which this paper has not touched. Stellite and Stoodite welding rods have been used on surfaces which are subject to heavy abrasion, as on chipper bed plates and knife edges. Unfortunately, space does not permit further comments, other than that we of the paper industry are very appreciative of the strides welding methods have made and are staunch backers of this art.

Welded Roof Construction Assures Permanence

A recognized advance in permanent roof construction was made a short time ago when the Fenestra Holorib Steel Roof Deck was arc welded to the purlins on the new cold draw building of the Babcock & Wilcox Tube Company at Beaver Falls, Pa.

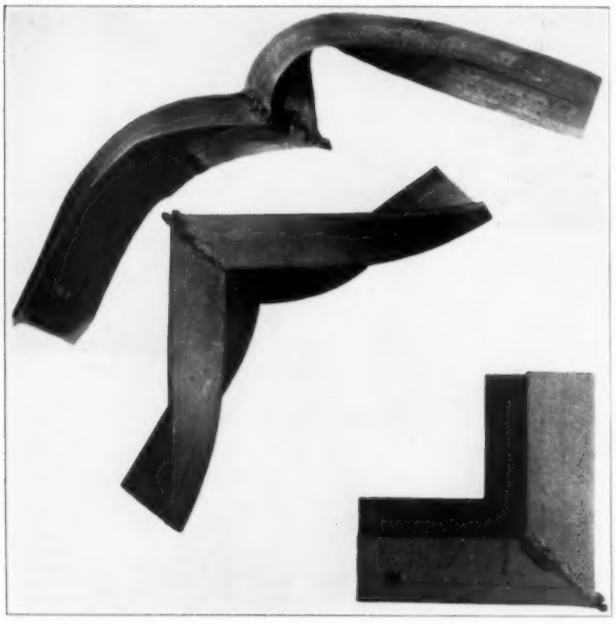
When Welding Was Used, Construction Time Was Cut Down. Insert Shows How Ends Are Welded.

Until this time the Holorib Deck, like all other steel roof decks, was attached to the structural steel by means of steel clips. On this job the Fenestra Construction Company, under sub-contract with McClintic-Marshall Company, obtained two portable motor generator sets from the Lincoln Electric Company of Cleveland, and with twenty men laid

99,700 square feet of Holorib copper bearing steel roof deck in sixteen working days.

This speed was made possible by fastening the end of each sheet at the base of the middle two ribs, the other end being telescoped three inches into the preceding unit. All welds were painted before being lapped. The steel decks were then covered with ½" of insulation and three plies of asbestos water-proofing felt.

Welding the center two ribs of each Holorib Sheet insured a holding power at each point of contact in excess of 500 pounds direct pull, in fact, under repeated tests the weld



These Tests Indicate the Strength of Welded Window Frames.

proved to be stronger than the sheet itself—the sheet tearing before the weld separated—this copper bearing steel sheet has a tensile strength of 50,000 pounds per square inch.

An analysis of costs after the operation was completed indicated that when the saving in the cost of steel clips was taken into consideration, the stronger more permanent welded operation cost but very little more than the former method of clipping. For this reason the electric welding method has been used on many other important installations since its initial success on the Babcock-Wilcox operation. Some of the other large jobs were the Albany Power & Light Company job at Albany, New York, the General Electric installation at Peterboro, Ontario, and the large Roach-Appleton job at South Bend, Indiana, where a big proportion of the roof was of the saw tooth design.

It is interesting to note that when the Holorib Steel Roof Deck was purchased for the large Travel & Transport Building being built for the Chicago World's Fair it was decided not to use the welding method of attachment because it would be too permanent—the steel clip method offered better opportunities for salvaging the material.

For many years Fenestra Windows, made of solid rolled steel bars, have been used for factories and industrial buildings, and are today considered the standard of construction wherever new factories or warehouses are being built. These industrial windows have been, and are, assembled by the familiar mortise and tenon method with air hammer riveting.

About seven years ago, however, the Detroit Steel Products Company, manufacturers of Fenestra Windows, decided to enter the residential building field with a casement type of window made of specially designed sections of solid rolled steel.

The demands of the residential building trade, especially when used in fine homes and large apartments, made it necessary to provide a more rigid, accurate window. In order to weather properly the frame and ventilator sections had to fit snug and tight at both jambs, head and sill, and had to retain this accurate fit regardless of how many times the window was handled by wholesalers and retail dealers before it was actually delivered on the job. After many experiments it was decided to miter and butt weld at all corners by automatic electric welding machines. This produced a finished product that was many times stronger and more rigid than could be obtained in any other way. During the experiments a solid rolled steel bar used as the outside section of the window was subjected to the torsion test after welding and it was demonstrated that the weld was stronger than the bar itself. This is proved by the accompanying illustration.

Today the Detroit Steel Products Company manufactures a complete line of high-grade windows for hospitals, schools, office buildings and monumental buildings, using a much heavier solid steel section, and subject to a rigid inspection of precision methods of assembly. These quality products are all butt welded at all four corners in order to assure satisfactory accuracy, rigidity and strength.

A.S.M.E. Welding Specifications to See Final Action in June

"The proposed Codes for Fusion Welding of Unfired Pressure Vessels and of Drums or Shells of Power Boilers were considered at the meeting of the A.S.M.E. Boiler Code Committee held on April 23rd. Important changes were made in view of the criticisms and suggestions that had been received, including those from the American Welding Society and the Compressed Gas Manufacturers Association. The proposed Codes with the revisions which were agreed upon will be published in the June issue of "Mechanical Engineering." It is contemplated that final action will be taken at the June meeting of the Boiler Code Committee, and it is important that all discussions be received before June 15th. Preprints will be available about May 15th, and may be secured by communicating with the Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y."

Fuel Depot Steam Line Is Gas Welded

The United States Government has awarded a contract to Thomas Haverty Company of Los Angeles, Calif., for the construction of an all-welded steam line and return line for use in pumping fuel oil to government ships in the San Diego Harbor. A view of this line taken near the Govern-

A View of the Gas Welded Steam Line Near the Fuel Depot.

ment Naval Operating Fuel Depot, is shown here. The steam line is six-inch, and the return line three-inch. Both are welded by the oxy-acetylene process. The line, which is about 1,000 feet in length, will have eleven elbows, six 8½-inch travis expansion joints, and will be tested to 500-lb. pressure. Hubert Carr is superintendent of the work for the Haverty Company and L. J. Peters is doing the principal portion of the welding.

The Use of Copper Forms in Shape Welding

A Method of Welding to Accurate Shape Which Conserves Time and Expense

By Miles C. Smith

OFTENTIMES the use of a copper form in a welding operation will convert loss to profit. The copper form confines any weld deposit to the desired area or form and thus eliminates much if not all grinding, yet the copper form is naturally most efficient when the weld is made electrically. In oxy-acetylene welding, the torch flame, if it be allowed to come in contact with a copper form, will fuse the copper with its relatively low melting point before the metal being welded and the welding rod are fused.

However, while the copper form comes in play chiefly with the electric arc process of autogenous fusion welding, forms may be used to advantage with oxy-acetylene welding. For oxy-acetylene welding the forms instead of being made of copper should be made of carbon plates, graphite, fire clay or other substances which are not greatly effected by the heat of the oxy-acetylene torch flame. So, while this discussion will deal almost entirely with the copper form and the electric process, the same general procedure could apply to oxy-acetylene welding by substituting a material that would be unaffected by the heat of the torch flame wherever copper is mentioned.

Copper forms have been used to greatest advantage, perhaps, in the building up of oil-field drilling bits with the electric arc welding process. For such operations specially shaped forms are utilized which assure that the welded-on deposit will conform to the desired size and design of the bits and by their use the welding is considerably speeded up and the grinding is reduced to a minimum. A considerable amount of the experience gained in oil-field bit fabrication procedure may be used to advantage in many other welding operations as well, particularly in welding back to shape machinery parts that have been broken or worn in service.

Briefly detailing some of the most common welding operations in which a copper form greatly assists in success, the common butt weld could be mentioned first of all, for copper backing can almost without exception be used to advantage in making butt welds electrically, that is, if the weld is made on carbon or carbon alloy steel of the common varieties. If the weld is made on stainless steel of the chrome-nickel type the backing should be steel and not copper and the steel should be recessed slightly to permit a slightly oval bead to form on the back as well as the front of the stainless steel being joined. Aside from the stainless steel, though, the copper backing is most useful and most efficient.

Another particularly advantageous use of the copper form is in the renewing of gear teeth. This operation can be speeded up to an almost unbelievable extent by following a simple procedure that is open to any welding shop. Gears, whether they be large or small, or regardless of their service, become unfit through the wearing away of the gear teeth. The teeth become thinner and thinner, permitting more and more play in the gear train until they would eventually break off or wear away entirely. However, in the majority of instances the wearing away occurs on one side of the teeth only.

In order to rebuild these worn gear teeth accurately and speedily it is essential that a copper form be made which will be the exact shape and size of a new tooth of the gear to be built up. This form should be attached to a guide or strap for holding it in place or two copper teeth may be made and strapped together at the proper pitch of the gear.

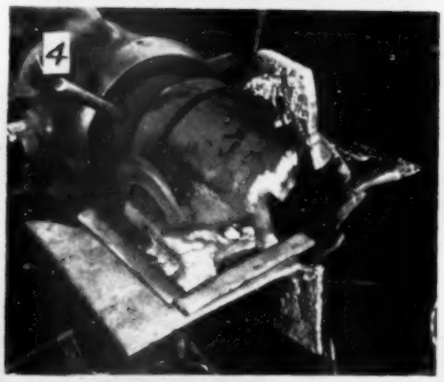
Detailing the building up procedure, the copper tooth form is placed against the unworn or least worn side of the gear tooth and a welding bead is run along the top and at the one or both ends and the copper form is then removed. The same procedure is followed for each tooth until the gear has been completely encircled. Following this, the gear is turned so that the recess formed between the beads made along the copper form is on the horizontal and this recess is then welded level with those beads.

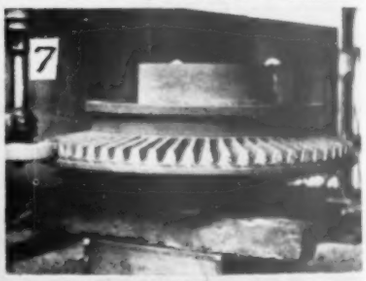
With this procedure there will be a surprisingly small amount of grinding necessary to form a quite accurate gear of the absolute original pitch. Without using a form the operation would be tedious and inaccurate.

Flat copper plates and copper hand strips may be utilized in a multitude of different ways. For example, when it is desirable to build out a part which has a comparatively thin section, the part may be placed on a copper plate and the building-out consists in welding almost entirely against the copper plate. Likewise, with the hand strip the weld deposit may be confined to any desired area regardless of whether the welding is being done on the horizontal or on the vertical.

Copper Form Welding Procedure in Pictures

Figure 1. A Special Triangular Form Is Used in Building Up an Odd Shape. A Spring Jack Is Used to Hold It in Place. Figure 2. The Form Gives the Welder Accurate Dimensions in Which to Make the Deposit. Figure 3. A Large Curved Copper Form is Many Times Helpful. A Sketch of the Finished Shape Gives the Welder Definite Information on the Weld Deposit Required. Figure 4. Loose Copper Side Plates Confine the Weld to Proper Dimensions. When the Weld is Formed, the Plates Can Be Removed. Figure 5. Copper Hand-Strips Are Useful in Nearly Every Type of Welding. Figure 6. The First Step in Rebuilding Worn Gear Teeth. A Copper Form of the Same Dimensions as the Tooth Is Prepared and Put in Position. A Bead Is Then Run Along the Top and End. After the Recesses Have Been Filled, the Teeth Are Ground. Figure 7. The Finished Gear Is Shown in Figure 8—Accurate in Dimensions, Quickly Rebuilt With No Waste of Weld Metal and a Minimum of Grinding Time.





Molten steel will not amalgamate with pure electrolytic copper and since welding may be considered almost in its entirety as a fusing and casting operation the electrolytic copper forms can well be utilized wherever it is found necessary to shape the formed casting with a mold. Without the form, the desired shape can only be approximately formed in the welding and then ground or machined to the desired dimensions. With the form, the weld deposit can be confined to such an extent that only a small amount of machining is necessary and the material used to form the weld is greatly conserved. So, even though it entails some amount of preparation to prepare a copper form of the desired size and dimensions, it is most often more economical to prepare the form than to make an attempt to get along without one.

F. T. Llewellyn Makes Up-to-Date Survey of Welding Processes

A COMPREHENSIVE survey of the various welding processes by F. T. Llewellyn of the United States Steel Corporation, past president of the American Welding Society, first appeared in *Metal Progress*, and since then has been published in several technical magazines, including the *Journal of the American Welding Society*. A particularly interesting feature of this survey is the accompanying chart which classifies the principal welding processes and divides them into two general fields of plastic welding and fusion welding, the first group requiring pressure to complete the weld and the second group requiring no pressure. The article itself explains the reason for this division and gives a brief description of the method of applying each process. Those portions of Mr. Llewellyn's paper which should be of particular interest to our readers are the Discussions of Testing Methods, Physical Properties of Welds and the Fields of Use. In the discussion of Physical Properties, which is reproduced below, there will be noticed a distinction between the methods of determining physical properties of objects welded by a resistance process as compared with those welded by a fusion process. In the discussion of Fields of Use, an interesting contrast is offered between the older methods of uniting metals and the welding methods.

Testing

Welded specimens may be tested by destructive methods in the same manner as are base metal specimens, but their yield point and ductility are not readily determinable by these means. Since the yield point of the weld metal deposited by fusion is frequently higher than that of the base metal which has been united, necking will occur in that part of the test piece comprised of adjacent base metal before the weld metal is fully stretched. Yield point and ductility can be ascertained by testing specimens made entirely of virgin weld metal, but such tests do not necessarily reflect the character of the welded assembly. Several forms of bend test have been developed with a view to confining the part measured to the weld metal, and there are grounds for expecting that acceptable standards for so doing will be established in the near future.

The soundness of a weld may be determined non-destructively in various ways. For laboratory use, electrical, magnetic, and X-ray methods are employed. In the electrical method the variation in resistance to passage of current is used to detect the location and magnitude of a defect within the weld. In one magnetic method an oscillograph records any difference in the composition of the specimen being tested as compared with that of another specimen whose quality has already been determined.

Testing methods used in the shop and field are of a more qualitative sort. The nature and regularity of the crackling sound produced by a welding arc have been found to reflect the uniformity of a weld. In all fusion processes visual inspection of the exterior of the weld has real value as an indication of its integrity. The interior of a weld may be explored by means of a gas torch, the portion so melted being subsequently re-welded. A stethoscope may be employed to detect by means of sound the location and extent of any non-homogeneous portion of the weld. Much emphasis is placed on the assurance of weld quality secured by periodical qualification of operators, wherein they are called upon to weld specimens which must develop predetermined unit strength when tested to destruction. Proof tests may sometimes be applied to the finished work by observing its behavior when subjected to a load of 1½ to 2 times that for which it was designed.

Physical Properties

The strength and ductility of objects welded by the older forge processes are adequate for the minor uses to which such products are now put, but these uses do not include joints having high predetermined efficiency. No unit basis has been suggested for rating the physical properties of forge welds, made by hand on an anvil.

In all resistance welding processes the efficiency of a joint depends primarily on the suitability and the adjustment of the machine employed for each specific purpose. If the electric power is too high, or its duration too long, the metal will be overheated. If the mechanical pressure is too high, the length or the cross-section of the welded material will be excessively reduced. If either of these factors is too low, no union will result. With an adequate machine that is kept in proper adjustment any resistance process produces a weld whose strength and ductility are substantially equal to those of the parts united.

Physical properties of resistance welds are determined in a different manner than for most of the fusion processes. For instance, the efficiency of an individual type of joint welded by electrical resistance duplicates what has been found to result from the employment of an automatic machine specially designed to suit that type of joint considered as a whole. On the other hand, in fusion welding the efficiency of a joint, in terms of some unit of its area, is predicated on tests that have been made on similar joints (but not necessarily duplicates), made by a similar method, but not necessarily with the same equipment. In both processes qualification tests should be applied; test the machine for resistance welding; test the operator for fusion welding.

Strength of welds made by either the gas or the arc fusion process may reach almost any desired amount, depending on the details of the process and on the grade of weld metal used. If the rod is a suitable grade of soft or medium steel, the tensile and shear properties of the welded joint may be conservatively expected to average approximately as shown below:

Ultimate tensile strength	50,000 lb. per sq. in.
Tensile yield point	40,000 lb. per sq. in.
Ultimate shearing strength	36,000 lb. per sq. in.
Tensile modulus of elasticity	29,000,000 lb. per sq. in.
Shearing modulus of elasticity:	
G (American double basis)	10,500,000 lb. per sq. in.
E2 (Metric single basis)	21,000,000 lb. per sq. in.

In general the ductility of a gas weld is higher than that of an arc weld produced in the ordinary manner with bare filler metal, but the ductility of either may be improved by the several means previously described.

The resistance of fusion welds to shock and fatigue has not yet been fully determined on a unit basis, but many joints made by these processes have been subjected in industrial service to severe impact, over long periods of time, without

showing sign of distress. Experience indicates that a weld whose length is parallel to the direction of stress will resist shock better than one disposed transversely.

Ultimate tensile strength of an unworked thermit weld, not heat treated, made with an ordinary mixture of thermit metal, may be placed at about 70,000 lb. per sq. in., with an elongation in 2 in. of 20 to 25%. By suitably varying the composition of the mixture, welds having lower strength and higher ductility, or vice versa, as well as great resistance to wear, may be secured. Thermit welds stand up very satisfactorily under drop test.

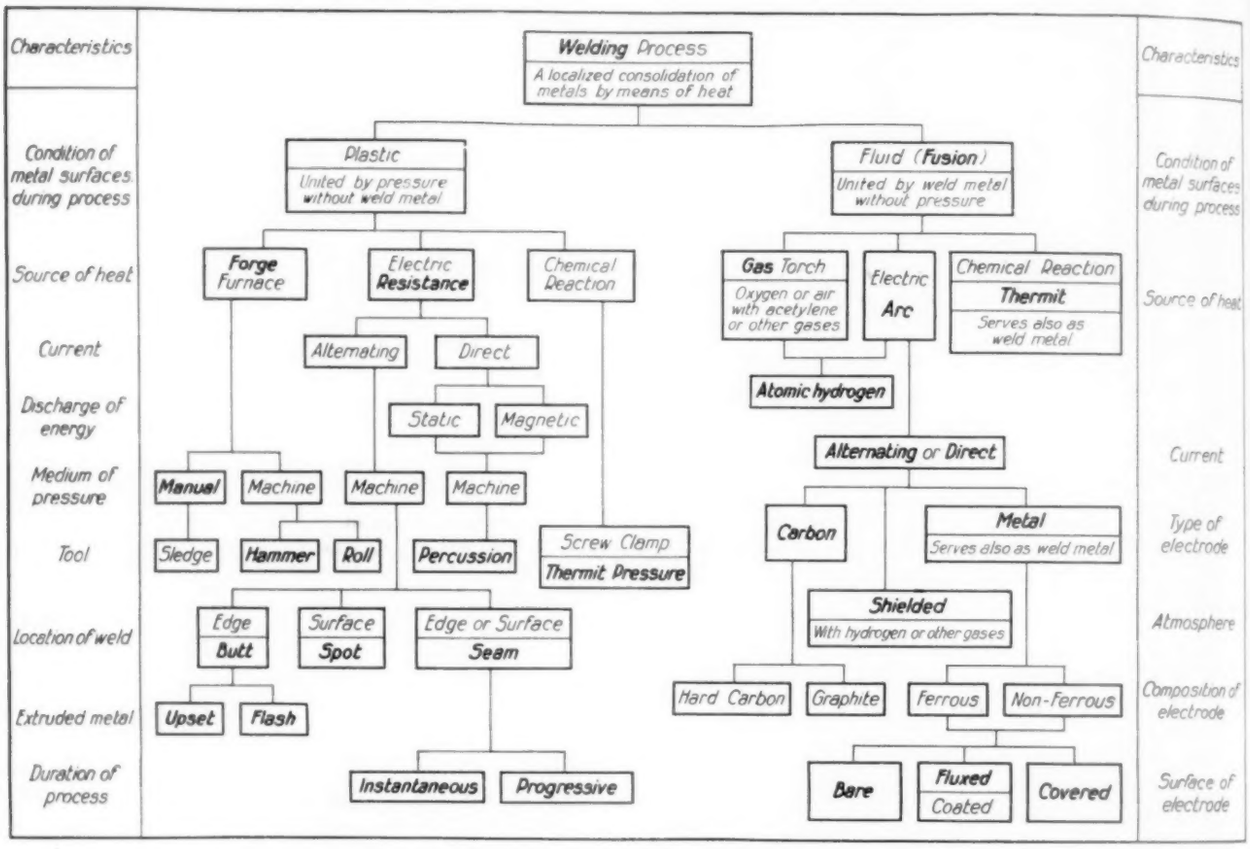


Chart Showing General Classifications of the Welding Processes.

Fields of Use

Two basic methods other than welding have long been employed to unite metal parts for the purpose of transmitting stress. One is a mechanical operation in which a portion of each part is first removed, in the form of round holes, slots, threads or other openings, and the removed metal is then replaced by interlocking pieces in the form of rivets, bolts, nuts or keys. The other method depends on surface friction between the parts, the friction being produced by mechanical pressure while the parts are cold or by the thermal shrinking of one part after it has been heated. Both of these methods reduce the available strength of the parts.

The fields to which the several welding processes are applicable are those in which it is desired to avoid the loss in strength incident to the older methods and those requiring the joining of parts of greater or smaller size, more irregular shape or in a more restricted space than is otherwise feasible. In the union of parts subject to fluid pressure the welding process provides a joint which is tight at all temperatures and which appears to reduce local corrosion (and caustic embrittlement in boilers). To a large extent the fields covered by the several welding processes differ, but there is some overlapping.

The field of manual forge welding is limited to small objects. Quite large and thick parts can be welded under the hammer process in many practical cases. For a long time butt-weld pipe up to about 3 in. diameter, and lap-weld pipe up to about 30 in. diameter have been roll welded, while pipe up to 96 in. diameter has been hammer welded. These fields are now being invaded by electric resistance seam welding for the smaller sizes and by fusion welding for the larger sizes. All processes of forge welding as applied to steel require a lower carbon content in the base metal than is necessary under the newer processes.

Butt methods of resistance welding are suited to fields where a strong joint is desired. They are applicable to either thick or fairly thin materials. For some years single sections having an area up to 36 sq. in., requiring 900 kva. and a pressure of 100 tons, have been welded by a combination of flash and upset welding. This limit has recently been surpassed by the welding of solid steel shafting $8\frac{1}{2}$ in. diameter and of 14-in. steel pipe with $1\frac{5}{16}$-in. wall, the respective cross-sections being $56\frac{3}{4}$ and 51 sq. in. A flash method is employed extensively in the joining of tubes and automobile rims and to unite the edges of sheets up to about $\frac{5}{8}$ in. thickness, as in the automobile bodies. Material whose edges are not exactly true can be welded by this process.

In theory, a spot process could be used to unite material of any thickness, but for very thick plates the enormous current and high mechanical pressure necessitates machinery so heavy as to be impracticable for most purposes. In addition it has appeared necessary to localize the spot area by means of buttons or other devices which so far have not proved commercially feasible. Therefore the field of spot welding has hitherto been restricted to thin material. A similar limitation formerly applied to seam welding, but recently improved methods have been developed, notably in the manufacture of pipe, which promise to raise the upper limit of weldable thickness to $\frac{1}{2}$ in. and perhaps even higher. The percussive processes are especially suited to the multiple

welding of different metals, or different grades of the same metal, as in the manufacture of automobile parts and tools, where it is desired to unite an expensive with a less costly portion. In all processes of resistance welding, except for very small parts, the weight of the welding machinery requires the work to be carried to the machine, and hence these processes are essentially factory operations. Their employment in quantity production is wide-spread. Based on value of product, probably three-fourths of all welding being done at the present time is performed by a resistance process.

While resistance welding is a rapid, multiple, manufacturing process, fusion welding may be called an engineering tool. Its field embraces all those applications wherein the strength of joints must be pre-designed on some unit basis, as well as a number of miscellaneous uses. In fusion welding also except when full automatic machinery is employed, the welding equipment can be taken to the work, thus making the process suitable for both shop and field. It is quiet, thus broadening further the locations where it may be advantageously used.

The gas process of fusion welding is widely used in the production of pressure vessels from the largest sizes down to light drums, the joining of pipe, end to end, and to fittings, the manufacture of products of steel, ferrous and non-ferrous alloys, the construction of aircraft, the repair of castings, maintenance of locomotive and railroad equipment, and in many other fields where its reliability and convenience make it suitable.

The metal arc process of fusion welding is well established as a production tool for welding the longitudinal seams of the larger sizes of pipe, the fabrication of pressure vessels, and in the construction of machinery bases and other parts. It is rapidly extending into the field of structural steel, where its simplified shop fabrication requirements, its possibilities for saving weight in design, and its adaptation to all kinds of reinforcement are frequently important factors. It is used for a considerable amount of steel plate and shapes in ship and barge construction and for many other purposes where speed and economy are desired.

The fields to which the shielded arc, the electronic tornado, and the atomic hydrogen processes are applicable have been indicated in describing their operation. So far the gas cutting process has been limited to ferrous products.

The thermit process proper is used where great strength, ductility and soundness are required in the repair (and at times in the manufacture) of very large objects. It is available whenever a mold can be placed around the parts to be welded. Originally all thermit welding was performed by those developing the process, but in later years users have been encouraged to do their own welding. Crucibles and preheating torches are about the only special equipment needed. Mixtures of thermit metal, suitable as to grade and quantity for the purpose desired, together with tables giving all necessary data, are commercially procurable. The process is used extensively for the reclamation of heavy machine parts, marine rudder-frames and propellers, rolling mill equipment, and other important work. It extends to such special fields as rail-joints, where rails may be made endless either by the well known insert method, or the base and web may be welded by a thermit fusion method while the head is welded by a thermit pressure method in which the rails are drawn together by means of clamp bolts. A thermit pressure method is also used for jointing pipes up to about six inches diameter.

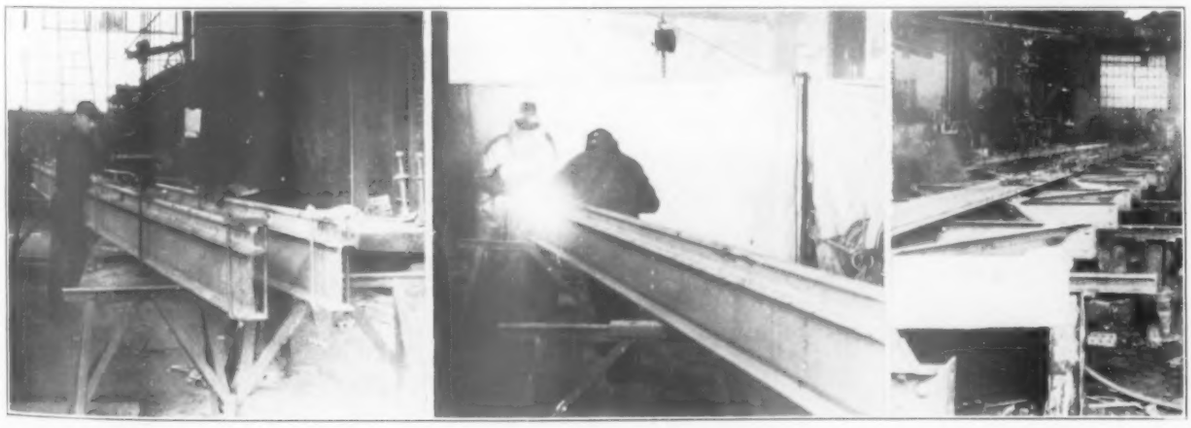
Arc Welded Track for Scenic Incline

By Jos. C. Coyle

In December, 1929, the highest suspension bridge in the world was completed over the famous Royal Gorge of the Arkansas River, near Canon City, Colo., providing the thousands of tourists who visit the gorge every season a means of crossing the mighty chasm by automobile for the first time. The Royal Gorge Bridge & Amusement Co., owners of this structure, have also constructed an all-steel scenic incline, by which the tourist may reach the bottom of the gorge near the swinging bridge of the Denver & Rio Grande Western Railroad, from a point near the new suspension bridge. Leaving a train at Colorado Springs, tourists may transfer to a bus which will convey them to the rim of the canyon, while the railroad train proceeds to Canon City via Pueblo. With ample time to enjoy the scenery at the gorge the travelers may then descend to the railroad by the incline and continue their trip, if they desire, by the same train they left at Colorado Springs.

The incline is 1,400 ft. long and constructed on a 100% grade. The entire 200 tons of structural steel used was prepared in Denver and shipped to Canon City, from which point it was hauled 14 miles by truck to the rim of the canyon.

An interesting and unusual feature of the construction is the welding of the 40-lb. rails of the track to the top of 10-in. I-beams, with a continuous bead on each side of the rail flange, giving the trackage a maximum strength with a minimum of weight. These I-beams were bolted to the steel cross-beams beneath the track by triangular-shaped angle plates, and joined at the ends by standard splice-bar joints. The cross-beams supporting the track were placed crosswise of a natural cleft in the canyon wall, which was taken advantage of in construction. This cleft ranges in width from 15 to 70 ft. The beams are from 15-in. to 18-in. size and 30 to 50 ft. long. Openings were blasted in the solid rock for the ends, which were then grouted in, or in many places set in a 3x10-ft. concrete pier. Concrete for the purpose was discharged from a



Left: Clamping the Rail and Stringer Together in Preparation for Welding. Center: Welding the 40-lb. Rail to a 10-Inch Stringer. Right: Trying Out a 120-Foot Switch Assembly—Rails Are in the Background.

½-yard portable mixer at the top of the incline into a wooden chute, passing by gravity to its destination.

The track, which has three rails—except for 120 ft. at the middle, where a double track was constructed for passing—was built from the top down, and the steel was lowered a piece at a time by a cableway from a 60-h.p. electric motor at the top.

In construction a triangular wooden scaffold, let down and drawn up with the cable, was used. This was 30 ft. long at

A Section of the Incline. The Working Scaffold and Derrick Are Seen in the Background. Concrete Travels Down the the Chute at Right.

the bottom, with steel flanges to hold it on the rails, and carried a working platform elevated so as to be practically level. On this platform a hand crab was mounted, by which to handle the 40-ft. boom on the front end, with blocks attached. This was used in swinging the steel into place. A rivet forge and supply of bolts and rivets were carried on the platform, and air was piped down the face of the cliff for operating the forge and the three jackhammers employed in drilling.

In preparing the steel at the Denver Steel & Iron Works, the necessary holes were first punched in the beams on a punch press, handling the steel with overhead blocks. The beams were then carried by the overhead crane to a specially constructed hand press, where any bends were taken out by two men. They were next placed on edge upon steel horses and the rails clamped on, using U-shaped rods, threaded at the ends to receive a steel block and nuts.

The beams were then carried into a canvas-inclosed booth, and a man at each side ran the metallic-arc bead, beginning at one end and working to the other. Particular care was necessary in fabricating the 120 ft. of switch and frogs; hence this was assembled together on benches in the shop, and after all parts were perfectly fitted together was taken apart again for welding.

The lower terminal of the incline is 25 ft. east of the swinging bridge of the Denver & Rio Grande Western Railroad. Shelters for passengers have been erected at both ends of the incline. It is expected that over 100,000 people will use the incline in a season. Two cars, carrying 21 people each and pulled by 60-h.p. motor at a speed of 300 ft. per minute, will be used.

Construction was by George E. Cole, engineer and bridge contractor of Houston. Hoisting and safety equipment is by the Otis Elevator Co.

Welding for the Chemical Industry

A very informative article under the above title, which recently appeared in *The Welder*, outlines the procedure for the electric welding of stainless alloys to meet the rigid requirements of chemical-plant equipment. The author, R. Leverick, points that in addition to the usual requirements of strength and tightness against leaks, inside welds in some cases must be smooth and free from holes and other surface imperfections as well as be corrosion resisting.

A comparison of the chemical composition of mild steel with an 18-8 stainless steel, using a typical steel in each case, shows that in the latter 26% of iron has been replaced with 18% of chromium and 8% of nickel, the other constituents remaining much the same. It is to this difference in composition that stainless steels owe their resistance to corrosion. Those stainless steels that are handled by the welder do not have to be polished to show their true properties, which, however, is not the case with a certain few special steels of this type. The steels met with in the chemical plant are stainless in the pickled condition, it is pointed out. Photomicrographs are reproduced to show the structures of mild steel and chrome-nickel steel and the structure of the weld in the latter.

To produce a weld having the characteristics and analysis of the stainless plate requires the use of the highest-quality plate and electrode, and welding equipment capable of fine adjustment, says Mr. Leverick. For this purpose a stainless-steel electrode is used surrounded with a covering which not only acts as a flux, but also as a heat insulator and at the same time excludes air from the molten weld and adds to the weld any element that may be lost by volatilization. Good welds, the author says, are being made with various values of current and voltage. The important thing is, however, that the composition of the weld metal and the plate metal must be near enough the same that when the two metals act as a galvanic cell (which is always the condition where two dissimilar metals are immersed in the same electrolyte) the corrosion is so slight as not to be detected. The author has found that this condition is attained, even in the case of highly corrosive media, where the difference in the chromium and nickel content of the two metals is not greater than 0.7% chromium and 0.5% nickel in the case of Stay-brite (an 18-8 alloy). These limits are the same for Anka (a 15-11 alloy); while for monel metal (65% Cu, 30% Ni), the limits are 4% copper and 3% nickel.

Welds that appear ideal will sometimes fail because of the initial presence of cracks so minute as not to be detected. Owing to any of a variety of causes, the liquid in these cracks may have a slightly different composition from that portion of the liquid touching the outer plates, with the result that a small galvanic-cell action is set up in the immediate vicinity of the cracks, the stainless weld acting as the short-circuiting medium. Such action is explainable in terms of Evans' theories of corrosion. Attack takes place at these points and the weld is weakened and may ultimately fail.

Such minute cracks usually occur at the junction where one electrode has finished and a new one begun. Tailing off is very helpful, but strict adjustment of voltage and current is the best plan. When such cracks form—and they usually form in groups—the weld should be chipped out and the seam cleaned up and rewelded, especial care being taken at the start and finish of the weld. Cracks that are too small to be visible often show up after a few days in a damp atmosphere.

In discussing the heat treatment of these steels, the author

points out that the usual corroson-resisting steels (15-18 Cr, 11-8 Ni) are incapable of being heat-hardened. In fact, raising their temperature to the change point (about 1050 to 1150 deg. C.) and cooling anneals them. They are, however, damaged by a temperature of about 800 deg. C., which produces thick-grain boundaries and loss of strength. The effect of the heat of the arc in welding is to raise a certain zone of the parent metal to this temperature. Hence, as soon as possible after the vessel is finished, the entire assembly should be heated to 1050 to 1150 deg. C., depending on the steel, and then cooled down. This will cause the characteristic structure of the dangerously heated region to disappear, giving place to the normal structure and restoring full mechanical and chemical characteristics.

Monel metal and similar alloys, the author goes on to say, do not suffer from this drawback, but instead they share a characteristic with pure nickel. All the high-nickel alloys are very brittle at a temperature just under the freezing point. Care is necessary when welding high-nickel alloys to insure that contraction is taken up at other places than the weld, and jigs are frequently necessary to avoid an undue percentage of scrap welds. After a little practice, welders can handle these alloys quite successfully.

While in the soft state the 18-8 group of corrosion-resisting alloys are very ductile, the effect of cold-working, such as rolling and flanging, is to increase their hardness greatly. The whole structure can then be normalized and the hardness reduced by heating to 1150 deg. C. and air-cooling. Monel and other members of the copper-nickel group do not work-harden to such an extent.

After all welding is done, whether the piece is to be heat-treated to soften or not, the whole of the scale and slag must be removed. This is best done by pickling the complete vessel and afterwards washing with water. This is necessary, as otherwise small electric cells will be set up between the plate and scale, causing corrosion.

This complete article on stainless alloys has been reprinted in pamphlet form by the Alloy Welding Processes Limited, Ferry Lane Works, Forest Road, London, E.17, England, for general distribution.

Bid for Welding Gantry Cranes Wins Construction Award

Four traveling, full-portal gantry cranes with weld connections and welded assemblies have been erected in a lumber storage yard on the Brooklyn waterfront. The general and detail construction of these cranes is described by R. F. Bessey in a recent issue of the *Engineering News-Record*.

Each crane has a total length of 113 ft. 3 in. and a height of 53 ft. 6 in. to the top of the main girder. The span between runway rails is 71 ft. 6 in. The specifications called for ample resistance against wind load and impact, and for a factor of safety of 5. No mention was made of welding; but the lowest of eight bids received, that of the American Crane Co., was based on the use of arc welding for all connections.

The acceptance of the welded bid was based on economy in cost and saving in weight of each structure, which was desirable because of reduction of soil pressure under the runway tracks, which were in part on new fill. The saving in weight is apparently about 30%, and the saving in cost is at least 15%.

Each welder, before starting work, was required to make up test specimens, all of which had to show a factor of safety of at least 5, based on the allowable stresses specified; and a number of specimens were also made in the form of actual joints of the structure. Taken as a whole, the tests indicated the anticipated reliability of the welded connections.

The two Pratt trusses forming the main bridge have 8-in. H-chords top and bottom, with the webs horizontal, and the verticals are 7-in. I-beams set into the openings between the flanges of the H's and welded along the flanges of both the H's and I's. The diagonals are pairs of channels welded to the outside of the H-chord flanges and battened together between joints. The top-chord bracing consists of I-beam struts butted against and welded all around to the flanges of the H-chords, and of flat-bar crossed diagonals. The cross-frames consist of the bracing strut mentioned, two channels at the bottom, and crossed diagonals of flat bars. The frame braces the bottom chord from the outside by struts made up of channels and welded to the chords and to the channel struts extended. The trolley runway beams are on the same level as the bottom chords, from which they are supported by plate brackets or gussets welded to the flanges of the H-chord and the I-beam verticals. The trolley rails are welded to the runway beams by short fillets at 18-in. intervals.

The portal on each side of the crane is formed by a distributing truss, from which the main bridge is suspended, and which is carried by two battered legs. Each leg tapers from top to bottom with the bending moment and consists of four angles with crossbracing in the upper (deeper) part and plate connections in the lower (shallower) part. Latticed four-angle ties or portal girders connect the bottoms of the two legs on each side of the crane. The only gussets used in the portal legs are some inserted to stiffen the connections at the distributing trusses at the tops of the legs. The welds of all angles are proportioned so their moments on each side of the center-of-gravity axis of the member are approximately equal.

In additional to the structural work, welding was also used to build the trolley frame, which is one unit, built up of plates, bars and other shapes; and the equalizing trucks under the four corners of the crane are of similar construction. The track wheels for both trolley and gantry travel are constructed of a forged steel outer rim, a hub of heavy steel tubing, and a web of a plate disc reinforced by radial bar stiffeners, all welded solidly into a unit. All gears are built up of high-carbon steel-forged rings for the rim or tooth section, hubs of extra-strong steel pipe, and webs of plate discs, all welded into a solid unit.

The cranes were assembled in large units in the shop to keep field welding at the minimum.

Report Anticipates Further Developments in Pipe Welding

At the convention of the Heating and Piping Contractors National Association, which was held in Louisville, Ky., May 6th to 9th, an item of particular interest was the report of the committee on welding. This report was presented by Mr. J. H. Zink of the Heating Power Corporation, Baltimore, who is a director of the association and chairman of the committee on welding. The report first called attention to the Standard Manual on Pipe Welding which has been completed and is now being distributed, and went on to say that it is reasonable to expect further welding improvements, particularly with reference to materials and equipment. It was also pointed out that in many instances the association is working in cooperation with manufacturers in the development of materials and equipment. Mention was also made of the fact that in the bulletin of the association, a great many articles had been published discussing the subject of pipe welding from practically every possible point of view. A strong plea was made for better standardization of practice and better promotional work. Mention was made of research work which is being carried out to determine the value of welding for the higher temperatures and pressures.

Welding Heavy Duty Equipment*

Better Products. Factory Short-Cuts and Lowered Costs Make Sales of Welded Products Easy When Backed by Quality Work

By W. B. Keelor†

THE following applications of welding are common in the products manufactured by the Whiting Corporation: Arc welding structural steel shapes, steel tanks, nickel, monel metal and corrosion resisting or chrome-nickel alloys; Metallic arc welding of cast iron, light steel plate, No. 14 gauge and heavier; the application of hard surfacing both with the metallic arc and the oxy-acetylene process; oxy-acetylene welding of light gauge steel plate and piping, cast iron in

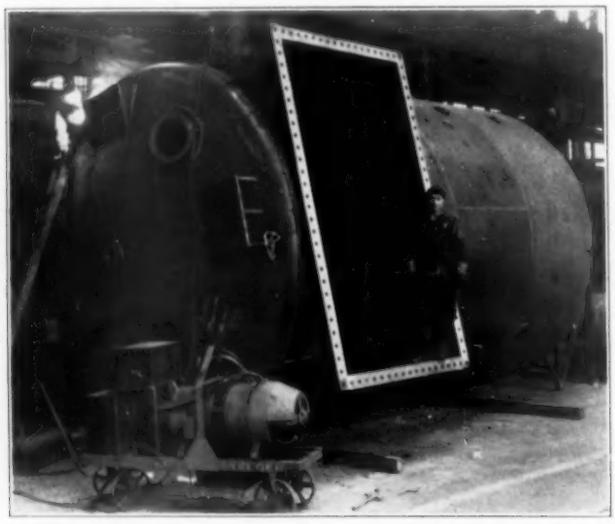


Figure 1. A 12-Foot Horizontal Tube Evaporator.

maintenance and bronze welding in maintenance; also automatic and hand cutting.

The products manufactured are as follows: Electric traveling cranes; hand power travelers; round house, job , bracket, bucket, pillar and gantry cranes; such railway equipment as screw jack locomotive hoists, screw jack coach hoists, turntable tractors, transfer tables; foundry equipment such as cupolas, charging machines and cars, ladles, tumbler barrels, trucks and cars, turntables, brass furnaces, steel converters, core ovens, malleable furnaces, air hoists, foundry elevators, trolley systems and sand conditioning machinery; evaporators for any liquid; pulp mill machinery, crystallizers and special chemical machinery. Also complete powdered fuel systems.

*Paper read before the February, 1931, meeting of the Chicago Section of the American Welding Society.

†Welding Supervisor, Whiting Corporation, Whiting, Ind.

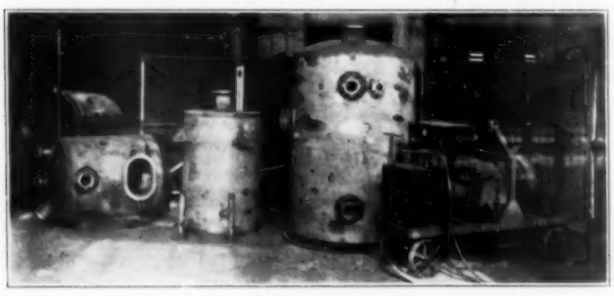


Figure 2. The Component Parts of a KA-2 Evaporator.

In all these products welding plays a large part. In some we find all-welded construction; in others we find very little welding, yet there is seldom a product shipped from our plant which does not have some welding on it.

Welding, to our firm, is a great asset. Our products are made better by its application; lighter in weight and at the same time stronger. Welding also embodies many short cuts in production, thus decreasing the cost of manufacture. Little do we realize how many of our products of today would be impossible without the application of welding, both because of design and of cost of manufacture.

In the manufacture of the various types of cranes mentioned, we come in contact with a great many applications of welding, such as trolley frames, bridge trucks, gear housings, gear guards and many others too numerous to mention. Outstanding accomplishments have been made in this phase of our work because of simplicity of design and reduction in weight. Both, of course, mean a great saving both to us and to our customers.

We found that a large majority of our customers were very skeptical about welding in the past. Some will gladly accept a product of welded design or perhaps insist upon it;

Figure 3. A Nickel Lining Is Welded into This Steel Bodied Evaporator to Resist Corrosion.

others will permit some parts to be welded but will not accept a product of all-welded construction, and still there are others who will not have a weld on any product they buy.

Our sales and engineering departments have fed our customers welding as fast as they would accept it and now the majority of them are willing and glad to buy a product fabricated by welding.

We believe that we do a very good grade of welding. We try to, and are instructed by the management of our company as well as the sales and engineering departments, to do a good job at all times, regardless of cost. This keeps us on our toes all the time and I believe this is the cause of our success with welded construction.

We insist that each operator identify his work with a

steel stamp which bears his mark or symbol. Each operator realizes that a failure in his welding will mean his job. If failure should occur in a weld after the job is in service, it can be very easily traced back to the welder. The quality of our welds has improved to a marked degree after this system was put into operation. It is surprising how uniform welding will become when it is used. If it were not for the different symbols, one would not be apt to distinguish any difference in appearance between welds made by our operators.

In our evaporator welding we deal with a great many metals and alloys. The industries served require vessels of nickel, monel metal, copper, lead, cast iron, steel and the chrome-nickel alloys. We not only make vessels of nickel, copper, monel metal and the chrome-nickel alloys, but also make coverings and linings for steel bodies of these materials. In this way we are able to hold the amount of these expensive

Figure 4. Sub-Station Oil Circuit Breaker Hoist.

materials used to a minimum. Only by welding can this be accomplished to advantage.

I find, in the arc welding of these materials, that the selection of the proper electrode, or I may say electrode coating and the operator's technique, are the factors of utmost importance.

It is quite necessary, or more accurately, essential, in this work, to arrive at a definite procedure and stick to it. By this I mean that one must find what size electrode to use for each thickness of material, what amperage is best to use for each size of electrode, at what angle the electrode should be held with respect to the work and what motion or electrode manipulation is necessary, if any, to obtain the best results.

Very strong and ductile welds can be made in nickel, monel metal and particularly in the chrome-nickel alloys, if the proper material is used in connection with a proven procedure.

Reverse polarity is always used in welding nickel and the alloys mentioned. The amperage required depends upon the type of electrode, size of electrode and thickness of material being welded. Too high or two low amperage may result in very poor welds.

We find that in making welds on materials of ⅜-in. thickness or heavier, it is necessary to preheat locally to assure maximum penetration at the start. This is done with the oxy-acetylene torch.

Nickel and the alloys mentioned may be welded to cast iron or steel with no great difficulty.

The accompanying illustrations are typical of the work done in the plant of the Whiting Corporation. Figure 1 is a view, during construction, of a 12-foot round-body horizontal tube evaporator. This piece of equipment is for pulp mill use and is constructed of ¾-in. steel plate and dished heads. The flanges which are welded on are of 1¼-in. steel plate cut to shape with the oxy-acetylene cutting torch.

Figure 2 includes the parts used in a KA-2 or 18 chrome 8 nickel evaporator. These bodies are made of ¼-in. plate and ⅜-in. dished heads. Inspection of welds in this equipment shows even distribution of slag over the bead with

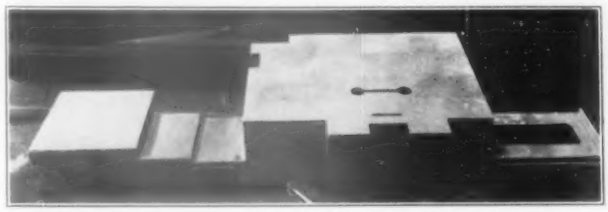


Figure 5. On a Hurry-Up Order This Base Was Delivered Quicker and Cheaper Than Would Have Been Possible if Cast.

bright metal underneath when the slag is removed. A nickel lined evaporator 8 feet 6 inches in diameter is shown in Figure 3. It is made of No. 12 nickel. All butt welds are covered with butt straps for additional safety, for if the solution should come in contact with the steel body, it would cause failure in a very short time. The steel body in this case is all welded ½-in. plate. Great savings are possible in making equipment with corrosion resisting linings when the entire unit is welded.

A piece of equipment which is used in power sub-stations is shown in Figure 4. It is an 8-ton capacity oil circuit breaker hoist, with a turntable mounted on the platform. This unit is designed for the handling of heavy circuit breakers in cramped quarters. It is entirely welded with the exception of those parts which have to be removed. Saving in weight with greater strength is achieved by welding.

Figure 5 is a special job that we were called on to do. It was wanted in a hurry and the pattern for the casting had been destroyed. Since prompt delivery was expected, we turned to welded construction. Steel plate, ¾- and 1-in. thick was used in making it. Parts were cut to shape with the oxy-acetylene cutting torch and then structured together with the arc. The cost to the customer was less than if it had been cast and that provided the pattern had been available. Many such instances of time and cost savings are to be seen in our routine operations.

In a plant as large as ours, or in a plant of any size for that matter, some safety precautions must be taken to pro-

Figure 6. This Screen Provides Safety for Passers-By in the Whiting Plant.

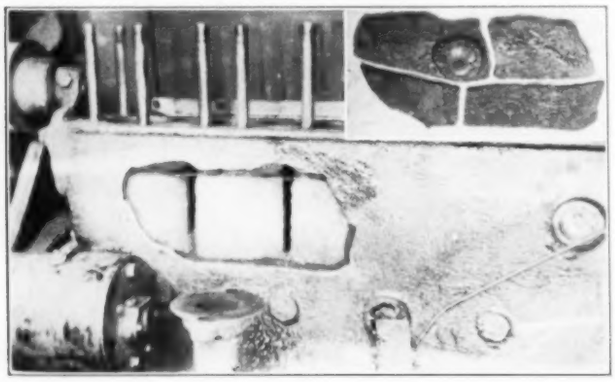
tect the eyes of passersby from the glare of the arc. Figure 6 shows a typical safety screen that is used in the welding department of the Whiting Corporation. It is made of 15 oz. duck painted with a fire-proof paint and hung on a hard drawn steel wire. It can be taken down and set up in a short time and does not require a great deal of floor space. It is extremely flexible since the wire may be located and fastened in any desired position quickly.

Hints for the Welder

WHEN YOU FIND a new way to do a hard job, or finish a particularly interesting weld, can you describe how the work was done? . . . . . Have you learned some little stunt every welder ought to know? . . . . . Write to us about these things . . . . . This department helps you welders to help each other. Write up your ideas any old way and just make rough pencil sketches . . . . We'll fix them up for publication.

Two Welding Methods Used on Engine Block Job

The proprietor of a Chicago welding shop sent us the accompanying photographs of one of the most difficult repair jobs which came to his shop during the past winter season. This was an engine block which cracked on account of freezing. The photographs show the hole which was made, the pieces which came out of the hole, and the appearance of the finished job. One peculiar feature of this case is that the safety plugs placed in the original cylinder for the purpose of preventing such an accident didn't work. One of these plugs is visible in one of the four pieces. In making the repair, the four parts were first welded together with the oxy-acetylene torch. The resulting piece and the hole in the engine block were ground and filed so as to obtain as good a fit as possible. Then the patch was welded in place using the metallic arc. The job was finished off with an iron cement to take care of any possible leakage. This job cost the owner of the engine $40.00 but saved him the cost of installing a new engine block.



Fracture in Cylinder Block Caused by Freezing. Insert Shows the Broken Pieces.

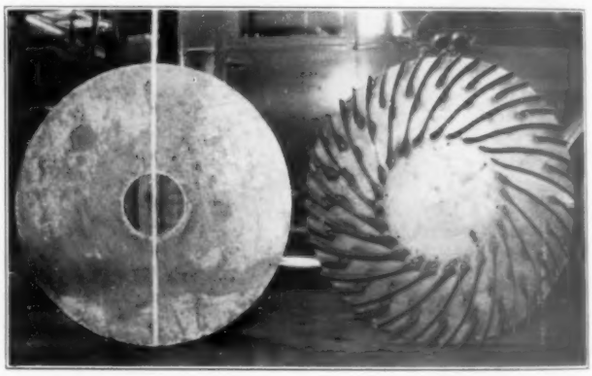
The Finished Weld in the Engine Block.

All Welded Suction Blowers For Vacuum Cleaning

By E. B. Heyer

These vacuum cleaners are very unusual. The average person has never seen one, because they are few and far between. These machines are over fifty times as large as an ordinary household vacuum cleaner and will do as much more work. They are a commercial article and built to order, generally at a great expense because the small demand does not allow mass production methods.

These units are more commonly called suction blowers and are used for heavy duty vacuum cleaning of all kinds such as: removing ashes and soot from furnaces, cleaning up the interior of large buildings, removing dirt and leaves from streets, etc. They are also used for the removal of light materials from one place to another, as in emptying a cargo of wheat from the hold of a ship. They are generally operated by gasoline motors if expected to be portable, although many are mounted stationary and powered electrically.



Front Rotor Plate Is Shown on the Left. Blades Welded in Place on the Back Rotor Plate on Right.

Welding and cutting make the building of special machinery, at moderate costs, possible.

Our shop is devoted almost entirely to the solving of special construction problems. We help design and build almost anything made of metal and were it not for the great possibilities offered by the various welding processes, our job would be a more complicated and harder one. From beginning to end our construction employs welding of one kind or another. Rivets are seldom used and bolts only where the unit must be disassembled.

With our first request for one of these large portable suction blowers we began to look up data such as we might find here and there, in reference to their construction and operation. Such information was very limited and not much help was derived from this source. We decided that by using the principle of the ordinary blower and adding

our own ideas where we saw fit, we would be able to build our first test model. This was how we started and it has worked out successfully. But, had we not used welding and cutting in the construction of these machines our experimental costs could have been monstrous. After having finished our first tests and become satisfied that the blade curve design was efficient, we built the blower for our customer. This also was all welded and each succeeding one has been done the same way.

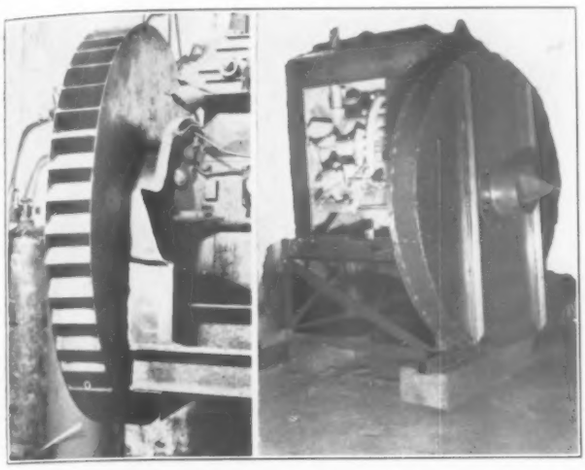


Figure 2. (Left) Side View of the Completed Rotor. Figure 3. (Right) The Complete Blower.

Our first step is to build the rotor. This is mounted directly onto the flywheel of the motor that drives it and is built of blue annealed sheet metal. The back plate of the rotor is the first part of the job. This is cut from 10 Ga. iron, 36 in. in diameter. The bolt holes by which this rotor is fastened to the flywheel, are then laid out and drilled. After this is done the plate is ready to have the blades welded onto it. The blades are of two sizes. There are 24 blades 4x13 in. and 24 blades 4x5 in. of 16 Ga. metal. In mounting we use a simple jig to assure exact spacing of each blade. These are welded (electrically) to the back rotor plate, as can be seen in Figure 1. In this illustration is also the front rotor plate, which is welded in place over top of the blades as in Figure 2. The rotor is then completed and bolted into place to be run and tested for balance. If out of balance the entire unit will vibrate and walk on the floor, in which case the rotor is removed and balanced by adding weight at the proper spots with beads of electric welding.

It is then necessary to have a casing for the rotor to travel in, and to guide the air stream into the dirt receiver for filtering. This casing is cut out of 16 Ga. iron and conforms to a spiral in order to accommodate the increased volume of air at the outlet. In Figure 3 can be seen the completed blower. On the front of the casing are two 1½-in. T-iron stiffeners. There are also two of these on the back, by which the casing is mounted onto the main frame. These are welded into place in order to give strength to the casing. The spacer between the front and back casing plate is made of 16 Ga. metal 5¼ in. wide and fastened with welding to the casing by ½-in. angles with bolts on the front for disassembling.

There is also an intake pipe in the center of the front casing plate. This is 8 in. in diameter and as deep. It projects through a hole in the casing plate and through a hole in the rotor, but about 1/16-in. clearance at this spot.

A flange is welded onto this pipe in order to bolt it to the front casing as can be seen on the completed blower. The entire unit is mounted on angle iron legs which are also welded. The time and material saved by use of welding and cutting in this construction has made it possible to build these blowers at a price within reason. All our future designs embody welding methods of construction, which we have found to be the most economical, quickest and strongest type of steel construction.

Bronze Saves the Hammer from Chipping

By I. V. Pennington

Here is another application for the welding torch in any small shop. We make a great many punches and chisels from Ford T Magnets but the steel is so hard that it chips the hammer that you are using. We finally built up the head with bronze and have not had any more trouble with splinters. This will work on any tool that tends to batter under the blows of the hammer and give off splinters that are dangerous.

How Old Man Contraction Can Be Outwitted

By E. H. Murrell

We now have commercial welds developing the full plate strength in practically all classes of steel plate, and this is due largely to our research people being able to outwit that old enemy "Oxidization." But we still have to contend with another foe of long standing who will always be in our midst. This fellow is a pretty husky chap. His name is "Contraction." He is stronger than any steel that science can develop, if he is not properly controlled. He is sly and tricky, sometimes doing unexpected things. He will tear your best weld apart just as you finish it or he will lurk in his lair until you are deceived into thinking he is not there at all. With all his strength and slyness, however, this fellow can be outwitted once we recognize him and get to know his tricks.

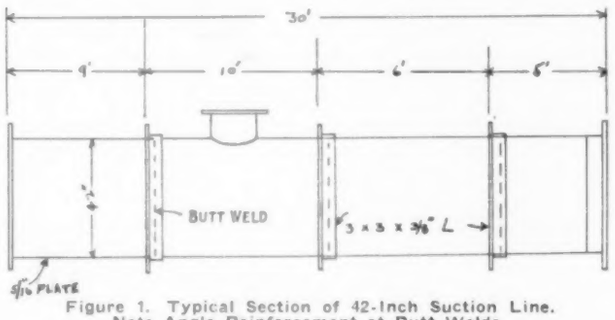


Figure 1. Typical Section of 42-Inch Suction Line. Note Angle Reinforcement at Butt Welds.

Figure 1 shows a typical example of welded plate work

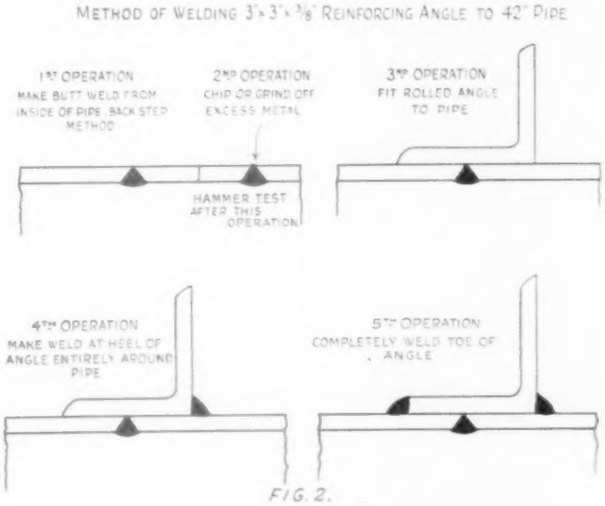

METHOD OF WELDING 3"x3"x3/8" REINFORCING ANGLE TO 42" PIPE
1ST OPERATION
MAKE BUTT WELD FROM INSIDE OF PIPE, BACK STEP METHOD
2ND OPERATION
CHIP OR GRIND OFF EXCESS METAL
3RD OPERATION
FIT ROLLED ANGLE TO PIPE
HAMMER TEST AFTER THIS OPERATION
4TH OPERATION
MAKE WELD AT HEEL OF ANGLE ENTIRELY AROUND PIPE
5TH OPERATION
COMPLETELY WELD TOE OF ANGLE

FIG. 2.

where contraction strains are liable to lurk. This is a butt-welded job in ⅛-in. tank plate with a 3x3x⅜-in. rolled angle placed over the weld as a reinforcement against collapse under a vacuum.

Several unsuccessful attempts were made to weld these angles to the pipe before it was found that old man "Contraction" was not being taken care of properly. He is a sensitive fellow and resents being ignored.

Figure 2 shows how we soothed his feelings. By following the operations outlined in this sketch contraction strains can be practically eliminated from a butt-strap joint.

Figure 3 outlines a somewhat different problem. This truncated cone is made of ¾-in. thick flange quality steel and in

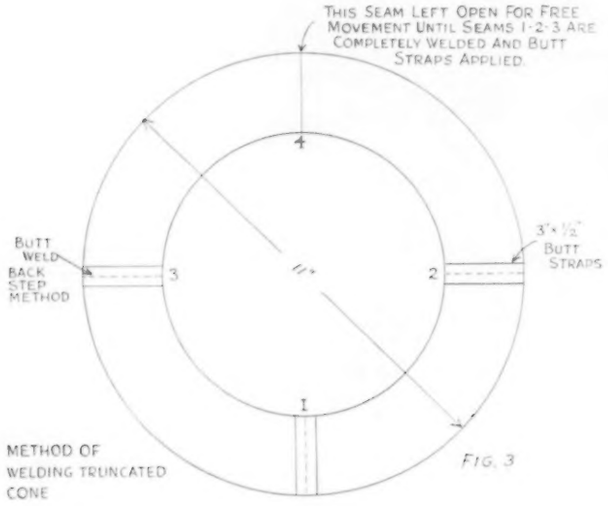

THIS SEAM LEFT OPEN FOR FREE MOVEMENT UNTIL SEAMS 1-2-3 ARE COMPLETELY WELDED AND BUTT STRAPS APPLIED.
4
BUTT WELD BACK STEP METHOD
3
2
3"×½" BUTT STRAPS
1
METHOD OF WELDING TRUNCATED CONE

FIG. 3

its finished state forms the bottom of a water jacket for a steam vessel. Should any contraction strains be left in these welds it is quite likely that they will not show up until the vessel is placed in service. This illustrates the trickiness of contraction—he delights in getting you in hot water with your clients.

Figure 3 shows how he was allowed to have his own way while at the same time we eased him gracefully out of the picture.

There are, of course, many other methods of outwitting contraction besides those illustrated. Stress relieving by annealing after welding is one example and a very important one, but not always available to the average plate shop. The point is that contraction is subject to certain rules which, when known, make him as harmless as he was once dangerous. The first and greatest of these is to let him have his own way as far as possible.

Low-Pressure Expansion Joint Has Unusual Welded Design

A very effective expansion joint for use in pipe lines has recently been developed through the use of welding, as is seen in the accompanying photograph. The use of these joints was developed by the Union Oil Company of California. The picture shows a view of the Venice oil field where these joints are being used quite extensively, and at a considerable saving.

This joint is constructed of two pieces of ¼-inch flange steel 32 inches in diameter. The line in which this joint is shown installed is a 16-inch line. Other sizes of lines, of course, would take different sized expansion joints proportionately, and depending upon the degree of expansion to be taken care of. The centers of these two sheets of flange steel comprising the joints are cut out to fit the pipe in which the joint is to be used. These plates are then cold pressed to a bell shape as shown in the photograph, and the two outer edges are welded together. It is then welded into the line by attaching each side of the joint to the end of the pipe joints at the point desired. Oxy-acetylene welding is employed in this work.

The thickness of this joint when completed is four inches, with a diameter, as stated, of 32 inches, or just twice the out-

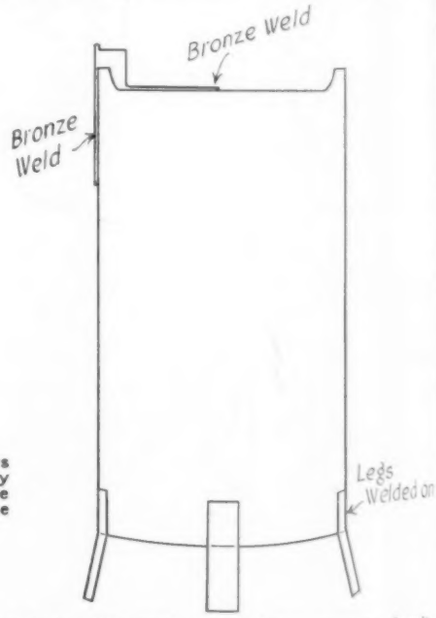
This New Type of Low-Pressure Expansion Joint is Welded from ¼-Inch Plate.

side dimension of the line which it serves. It is said that it will handle an expansion in the line of from four to six inches. A ½-inch pipe coupling is welded into the bottom for draining purposes. While intended primarily for low pressure work, this joint will handle up to 100-lb. pressure or more, depending upon its size and the kind of material used.

Handy Waste Containers Made from Old Grease Drums

By I. V. Pennington

In Nebraska a garage receives a 5 cent per hundred reduction in insurance rates by having the recommended number (according to size of building) of covered waste cans that set



This Sketch Shows How a Handy Waste Can Is Made from Old Grease Drums.

4 inches from the floor. We made ours from empty alemite grease drums.

We took a heavy strap hinge and bent it so that it would fit the lid as shown in the illustration. We bronze welded the hinge to the side of the drum and to the lid. The legs were strips of iron 6 inches long and 2 inches wide welded to the side of the bottom. A stop may be put to keep the lids from swinging too far back and then they will be self-closing.

Careless Use of Flame Is Dangerous

Danger lurks around empty fuel oil, crude oil, or gasoline tanks! Welders may well take warning from the silent reminder shown in the accompanying photograph. The thoughtlessness of a welder in lighting his torch too near the truck, caused an explosion which luckily did not cost him his life or injure anyone else. Other than a severe shaking up, the welder was uninjured, and due to the fact that the explosion occurred at two o'clock in the morning when no one else was about, no other personal injury was done. The force of the explosion moved a nearby frame dwelling house several inches off its foundation, and windows for a considerable distance were broken by the blast. Note in the illustration how the cab of the truck is demolished, and the rear section of the tank blown loose from the truck and other sections of the tank. The empty truck tank had recently contained crude oil, the fumes of which were escaping through an open rear gate when they ignited from the welder's torch. The accident occurred recently in an oil field in California.

This Is What Happens When Flames Are Carelessly Handled.

Building a Job Welding Business

By W. Irving Brockson

III—Keeping Up With New Developments

FROM the standpoint of being in an expanding industry rather than a retrenching one, the manager of a job welding shop is most fortunate. There are industries, of which the manufacture of horse drawn carriages is a good example, which once flourished and are now almost extinct. There are other industries which have reached a high state of development and according to the best authorities are due to decline. Then, there are still others which are in the expanding stage with a very bright future ahead of them and with no limits in sight. To the latter class belongs the welding industry.

Welding Has Made Rapid Strides

It is unnecessary to dwell at length upon the rapid strides which welding has made in the past ten years. Every one in the business is familiar with the progress made, with the many purposes to which it has been put, other mechanical applications and processes it has replaced, and the new fields it has entered. However, this very rapidity of growth places a responsibility upon the shoulders of every one in the business.

Necessity of "Keeping a Jump Ahead of the Pack"

A record of successful achievement behind one does not insure success for today and tomorrow. It is highly essential that every welding shop executive keep up-to-date on new developments as they come out. He should not be content furthermore, to be the pioneer in his district in the application of welding to one certain field, but he should be continually on the alert for other applications as they are perfected. He should develop plans and habits of thought whereby he can keep continually in touch with the sources of enlarging welding knowledge and practice. As new experiments are in progress, he should be in touch with their outcome; as improved technique is developed, he should master it; when new equipment is manufactured, he may not be able to buy it, but he should learn what it will do and attempt to make his old equipment fit into the new picture. Furthermore, if his own equipment gets so far out of date as to be a handicap, he should have the courage to "ditch it" in favor of the new and improved type.

Value of the Welding Journal

The values of trade journals are well known among the more progressive members of any trade or profession, and welding is no exception in this respect. Of necessity, these journals are edited by men who have a broad and thorough knowledge of the welding industry, and their success depends upon bringing to their readers the latest news, technical information and business developments related to the industry. Furthermore the pages of your journal are made up largely of articles which have been contributed by engineers, superintendents and successful job shop operators who are especially suited by long experience to handle the subjects which they discuss. In short, the editorial pages make up a clearing house for up to date information, and exchange of experiences—truly a "family round table."

Educational Value of Advertisements

But there is still another point of merit about your trade paper which is not always fully appreciated, namely, the advertising pages. Very frankly, these pages have been bought by the respective advertisers to tell their message to the readers and to further the sale of their products. But this very fact insures their reliability because no company can afford to advertise a product or a service without proven merit and moreover, the publisher of your journal would not accept an advertisement from an irresponsible concern. From these advertising pages you can learn about new and improved welding wire, welding equipment, etc. Also many of the advertisers offer free of charge, booklets or catalogs which present engineering tables and scientific data as well as valuable information about equipment and supplies. Reading the advertising pages, or sending for literature described, places you under no obligation to buy one red cent's worth of merchandise; but it does offer you a means of keeping abreast of the welding times.

Attend Welding Conferences

The welding convention, or conference, is the best place in the world to "rub elbows and swap ideas" with men who are up against the same thing that you are every day. The American Welding Society holds regular meetings in many large cities; several of the state universities are holding welding conferences every year, many industrial plants hold an occasional meeting to demonstrate or to discuss some new welding method, to weld some new metal, or to explain the ins and outs of some new type of welding assembly. If you have some problem that is bothering you or if you want the

latest information on some new development, you stand a mighty good chance of getting the "dope" you want at a convention.

Making Lasting Friendships

If your question is not answered in the formal talks given or in the discussion which immediately follows, you can, nine times in ten, find some one at the convention who can talk authoritatively on your problem. Possibly the best part of a convention is that it gives you a chance to get acquainted with people and, apart from the personal satisfaction of knowing them, it affords an opportunity to get on a friendly basis with other welders with whom you can either visit or exchange correspondence later when you are up against a problem that stumps you. A convention is more than a place to get "soused to the gills"; it is a place to become "saturated with ideas and sweetened with friendship."

Listen to the "Peddlers"

In some quarters, "peddlers" or salesmen are looked upon as an unadulterated nuisance—people to kick out the door "on their ears." Perhaps in some rare cases salesmen of welding rods and equipment deserve that attitude, but taken as a whole, salesmen these days are a pretty decent, intelligent lot—they've got to be to stand up under the hardships of their jobs. They are open and above board in their desire to sell you something, but whether you buy or not, you can in most cases get an idea—small or large—which has some value to you, if you give the "peddler" half a chance. Most of these men know their merchandise very well and are free in passing out information. Moreover, they get about the country all the time and gather considerable news of the industry. A few of them have for years earned their bread and butter with the torch and the arc and are thoroughly capable of giving practical demonstrations of their line. Perhaps you will buy from only about one in ten of these "knights of the brief case" that call on you but they all deserve a hearing. Even though you feel that you can learn nothing from a salesman, it pays to treat him courteously, because if you stand well with him he may be able to "do you a good turn" with your prospects.

An Inquiring Mind

Welding is growing, expanding and changing as rapidly as any phase of American industry. It is not enough for the job welder to have several years' experience before starting his business, or even to make use of the sources of information suggested above during the first year or so he is established and then "let down." He must develop an inquiring mind, one that is continually on the lookout for new ideas, regardless of the source from which they may come, and to this inquiring mind he must add the courage at least conscientiously to try those new methods which appear to have a bearing on the welding problems of his clients or prospective clients. "Eternal vigilance is the price of success," perhaps applies with more force to the job welding business than any other.

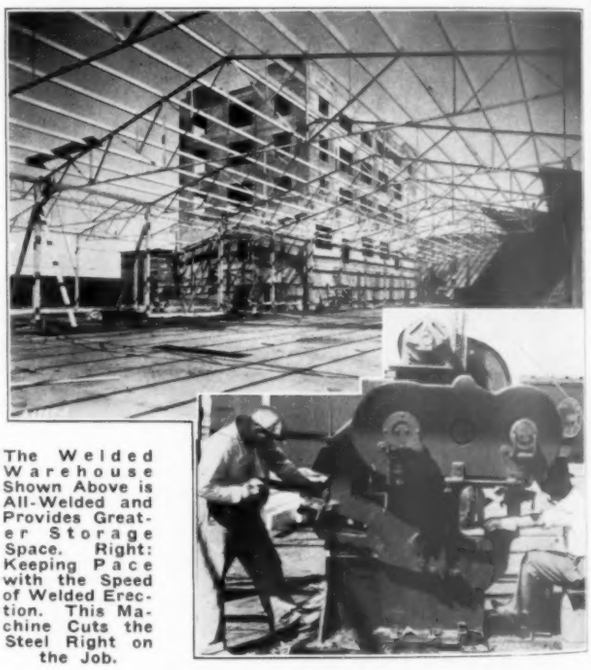
Spot Hardening with the Torch Saves Rail Ends

One welding problem which has given railway maintenance of way men plenty of room for research and experimentation is that of finding the most satisfactory procedure for building up battered ends of rails. Since the fundamental purpose of all this investigation is a matter of prolonging the life of the rail after it has been laid, it is interesting to note that on one ralroad considerable progress has been made in developing a method of prolonging the life of the original rail before it has actually been put into service, by using the oxy-acetylene flame to harden the ends of each rail. The procedure is described in detail in a recent issue of Metal Progress, in an article written by M. D. Bowen, Welding Superintendent of the Milwaukee Railroad. A small notch is ground in the joint; then the two ends are heated well above the critical point, this heating being done slowly enough to prevent cracking, and rapidly enough to keep the heat localized. The heated portion is quenched quickly; then reheated to 650 degrees so as to draw the temper. A special holding device has been developed for the torch to keep it at the right distance from the rail, and the temperatures are frequently checked by means of temperature testing apparatus. Mr. Bowen estimates that about 500 joints can be hardened in one day by a gang of seven men, with the proper equipment, and that 65,000 rails have been treated in this way on the Milwaukee Road. He states that rails which have been treated by this procedure are still in most excellent condition after a length of service which would undoubtedly have required some rebuilding of battered ends if they had been laid as received from the mills.

Arc Welded Warehouse Is Completed

The new warehouse of the Rice Growers' Association of California, at Broderick, California, is arc welded throughout, and replaces the wooden building recently destroyed by fire. This type of building was accepted in preference to the wooden type of construction, and at practically the same cost.

The new building is two hundred and sixty feet long, and covers a floor area of approximately thirty thousand square feet. The framework is of structural steel and the roof and sides are fitted with galvanized corrugated iron. The clearance from floor to truss is twenty feet and permits the full storage and piling of rice throughout the warehouse. Directly under the eaves on each side of the building is a row of steel sash, two lights high for daylight illumination, and sliding steel doors are placed at convenient points about the building to facilitate the handling of storage material.



The Welded Warehouse Shown Above is All-Welded and Provides Greater Storage Space. Right: Keeping Pace with the Speed of Welded Erection. This Machine Cuts the Steel Right on the Job.

This warehouse was designed and erected by J. Edmund Davies & Company of San Francisco, using two 200-ampere Westinghouse FlexArc welding machines. All steel used in the construction was shipped in stock mill lengths and was cut and fabricated on the site of erection. The entire building was completed in 30 days, the welding time being 23 days. The Davies Company have designed and erected many electrically welded buildings, and are considered as pioneers in structural steel welding on the Pacific Coast.

Producing Oxygen With Low Pressure Air

BY I. H. LEVIN*

An important development in oxygen producing plants was made several years ago when a cycle was developed using an expansion engine. This new cycle was used as the basis for building one of the largest oxygen producing units in the United States, capable of separating the air completely into nitrogen and oxygen simultaneously. The nitrogen can be made free from oxygen, that is, practically 100% pure, while the oxygen produced is of a purity of 99.5%.

500 Cubic Foot Per Hour Liquid Air Oxygen Plant

Left: Column and Engine of the Plant Shown Above. Above: In the Foreground the Oxygen and Air Compressors May Be Seen and in the Background Are the Air Purifying and Drying Battery.

Still more recently an air oxygen plant was installed for one of the Navy Yards. The plant produces oxygen, which is compressed into cylinders and is distributed throughuot the yard.

During eight years of research and development the present type of plant has slowly matured and finally become standardized and put into production. It is now offered as an American contribution to the field of air oxygen plants. This new type of plant operates with very low pressures and produces oxygen of 99.5% and better. In the plants of only 500 cu. ft. per hour capacity, the operating pressures are under 300 pounds, and in the larger plants, the operating pressures are still lower. These plants are comparatively small and so simple to operate that anyone who can tend an air compressor, can operate them.

In this plant, the cost of power, due to low operating pressures, is so far reduced that the simple, single rectification column is used. The regulation of the column is carried out by the operation of a single expansion valve.

To separate air into oxygen and nitrogen, the air is first liquefied, and the liquid is distilled into its main constituents, oxygen and nitrogen. To obtain the necessary refrigerating effect to cause the air to liquefy, the air is first compressed, then cooled by water, then expanded in an expander, producing work. The work produced comes from the heat in the air, and as the heat is transformed into work, the temperature of the air is reduced and a very appreciable refrigerating effect results. Once the air is liquefied and distilled into cold nitrogen and oxygen, these cold gases are sent into interchangers where they are brought into heat transfer contact with the air to be cooled. The air is cooled and the outgoing nitrogen and oxygen leave the interchangers at approximately the temperature of the ingoing air. These interchangers operate very efficiently with only a few degrees temperature difference between the air and outgoing gases. Although the compressed air is very much cooled this way, the amount of cooling is not sufficient to operate the unit, since an appreciable amount of heat flows into the apparatus in view of the large difference between the temperature of the room and the temperature of the air, particularly the temperature of the liquefied air in the distilling column. The heat interchangers and the column are insulated, but in spite of the best insulation, additional refrigeration must be produced. The air under pressure expanding through the engine, produces the necessary refrigerating effect to neutralize the heat inflow and the other losses.

To properly separate the air into oxygen and nitrogen, there must be provided means for purifying the air and dehydrating it. The air passes through towers containing an alkali such as sodium hydroxide, to remove the carbon dioxide. After the air is compressed, the air passes through a dehydrating agent as, for example, lumps of caustic potash which remove the water vapor. The air thus treated passes into a set of interchangers, to be cooled by the nitrogen and oxygen leaving the distilling column.

In time it becomes necessary to thaw out or defrost the interchangers and even the distilling column. Due to a special arrangement of the interchangers, the interchanger can be defrosted without shutting down the plant. The defrosting lasts about one-half hour, during which time the plant runs on as usual.

In this type of plant, operating with an expansion engine, an additional feature is provided whereby the plant can be operated either with the expander or can be operated by simply expanding through an expansion valve. When operating with an expansion valve, the operating pressures are somewhat higher than when operating with an expander. In the smallest plants, the operating pressures are within 600 pounds and in the larger plants, the operating pressures are still lower when operating without the expander.

This plant operates on a new cycle whereby one can produce a given amount of refrigerating effect with low pressures in the air engine. This particular cycle was devised during the search to produce a cycle of operations that would be adaptable to the production of oxygen in large quantities. It is to be remembered that in the operation of plants of this type, better operating efficiencies are obtained from the plant due to size alone for a given cycle of operation. The research policy is, therefore, to test out any new thermodynamic cycle on very small units, even though the new cycle might be designed primarily for large unit operation.

This unit is the result of many years of research and development by a group of men who have been among the pioneer builders of Oxygen Plants in the United States. The plant is being produced at Pittsburgh, by the Gas Industries Company, who as designers, manufacturers and operators of oxygen plants, have organized a complete oxygen service, for users of oxygen.

*Technical Director, Gas Industries Company, Pittsburgh, Pa.

Chicago Bridge and Iron Works Elevated Tank Contest

The International Competition, sponsored by the Chicago Bridge & Iron Works, of Chicago, George T. Horton, President, to develop an aesthetic improvement in the character of elevated water tanks, was brought to a conclusion Monday, April 20th at a final meeting of the judges.

The jury of award consisted of Mr. R. W. Zimmerman, Architect, Chairman, Mr. Howard L. Cheney, President of Chicago Chapter, American Institute of Architects, and Mr. George T. Horton.

This Design Won the Prize in the Contest for More Attractive Elevated Tanks.

The competition, the execution of which covered a period of twenty months, was conducted by Mr. Albert M. Saxe, Architect, as professional adviser. There were 691 applications to participate, resulting in 152 final presentations of drawings, so unusual and diversified in their scope that it is thought that this contest will result in a veritable renaissance of elevated tank design, which will be felt throughout the entire country.

The drawings on public exhibition for two weeks commencing April 27 in Chicago. Other exhibitions will be held in response to requests from numerous universities and architectural schools.

To Avoid Wage Cuts in Pacific Northwest

The Twenty-Fifth Annual Convention of the United Metal Trades Association of Pacific Northwest was held at the Multnomah Hotel, Portland, Ore., on April 25th, and brought together a representative number of the trade from the key cities of Washington and Oregon. The one-day program was replete with papers and reports pertinent to the trade and in addition the members were much interested in two talks dealing with the work of the soviet in Russia. Dr. A. J. Schleuning spoke on "The Political Situation in Russia, Yesterday and Today," and Prof. W. H. Taylor, Reed College, discussed "The Five Year Plan."

O. R. Rabel of Seattle presided at the convention, the keynote of which was the wage scale. Comparative figures between local and national were given and explained by Secretary Garretson of Seattle.

The bulk of the afternoon session was given over to wage discussion in open forum, and while no resolutions were passed it was the unanimous decision there will be no reduction in wages in the metal trades in the Pacific northwest. A number of the speakers stated that while business is not booming, it would be poor policy to have a general decrease in wages.

New officers elected included C. H. Pape, president, Portland; Albert Worley, Tacoma, first vice-president; Fred C. King, Portland, second vice-president; E. D. Doran, Seattle, third vice-president; H. C. Forsberg, Portland, treasurer, and F. J. Danaher, Portland, re-elected secretary.

The officers of the Washington district present at the convention were John Isaacson, president; Frank McKenzie, treasurer, and A. H. Garrison, secretary, all of Seattle; J. M. Fitzpatrick, of Union Iron Works, Spokane, and president of Inland Empire district.

To Sell Weldit Products in Eastern Ohio

Effective May 1, 1931, the Weldit-Acetylene Company, Detroit, will be represented in the eastern half of Ohio by an organization of trained salesmen and service men under the direction of Mr. William B. Boom, president and general manager of The Boom Boiler & Welding Co. of Cleveland.

Mr. Boom has been prominently identified with both the gas and electric process for the past fifteen years, and is in a position to afford expert engineering advice on all welding problems.

The company will be known as Boom-Weldit Company, located at Main and Elm Streets, Cleveland, Ohio.

To Formulate Standards for Electric Welding Apparatus

F. M. Farmer, representing the American Institute of Electrical Engineers and the American Welding Society, has been appointed chairman of the ASA sectional committee on electric welding apparatus, the personnel of which has just been approved by the American Standards Association. In accordance with the scope of the committee's work, which was also approved by the association, the committee will work on the formulation of standards for electric welding apparatus, including definitions of terms, classification, rating, heating, efficiency, testing methods, dielectric test, standard values of current and voltage and nameplate data.

The basis of the committee's work will be standards submitted by the American Institute of Electrical Engineers on electric arc welding apparatus and electric resistance welding apparatus.

The National Electrical Manufacturers Association is joint sponsor for the project with the American Institute of Electrical Engineers. Objections to the A. I. E. E. standards were raised by the National Electrical Manufacturers Association and at the request of the sectional committee this association is now formulating a statement of the exact nature of its objections.

The committee's personnel as approved by A. S. A. consists of the following:

American Bureau of Shipping—J. L. Wilson.

American Electric Railway Association—F. McVittie (New York State Railways).

American Institute of Electrical Engineers—A. M. Candy (Westinghouse Electric and Manufacturing Company); J. W. Owens (Welding Engineering & Research Corporation); F. M. Farmer (Electrical Testing Laboratories).

American Institute of Steel Construction—F. H. Frankland.

American Railway Association—Lem Adams (Union Pacific Railroad).

American Society of Mechanical Engineers—N. M. Loney (Fisher Body Corporation).

American Welding Society—F. M. Farmer (Electrical Testing Laboratories); Frank P. McKibben (Consulting Engineer); W. Spraragen (American Bureau of Welding), alternate; E. Vom Steeg (General Electric Company), alternate.

National Electric Light Association—A. B. Morgan.

National Electrical Manufacturers Association—James Burke (Burke Electric Company); L. D. Meeker (General Electric Company); F. W. Eils (Northwestern Manufacturing Company), alternate; W. W. Reddie (Westinghouse Electric & Manufacturing Company), alternate.

Society of Automotive Engineers—Alexander Churchward (Wilson Welder and Metals Company).

U. S. Navy Department—Lt. Com. N. L. Rawlings.

Members-at-large—H. A. Woofter (Swift Electric Welder Company); R. S. Donald (Thomson-Gibb Electric Welding Company).

E. H. Ewertz Awarded Miller Medal

At the close of the annual spring meeting of the American Welding Society which was held in New York City last month, the Samuel Wylie Miller Memorial Medal, which is awarded each year by the society for outstanding achievements in the field of welding, was presented to Mr. E. H. Ewertz of New York City. Mr. Ewertz is widely known as one of the pioneers in the development and application of the welding processes. For many years he was engaged in ship construction and contributed a great deal to the progress which ship builders have made in the applications of welding in shipyard work. He has long been an active member of the American Welding Society and at one time was president of the organization. He is the owner of a series of patents covering a method of welding ships and one ship has already been built according to the designs which he has developed. At the present time Mr. Ewertz is a consulting engineer specializing in arc welding.

Cleveland Welding School Adds Specialist Courses

The Cleveland Welding School, Cleveland, Ohio, has recently made some additions to their courses which they find will make it possible for the welding specialist to broaden his specialties without the necessity of his taking the complete course; also the student who desires to specialize can do so in a shorter time and at less cost. Previously they have had only a complete course in either arc or gas welding and one which covered both fields thoroughly. These courses are being retained and the following added: special alloys, cast iron, steel, sheet aluminum, cutting, sheet metal, pipe and also a special course covering only overhead arc welding. The two courses covering special alloys and sheet aluminum are only available to men who have already taken the general course or are already seasoned welders, as it is the experience of this school that the student must be trained in the fundamentals of welding before he can specialize on these two metals.

Pittsburgh Distributor Features One Specialty at a Time

One of the largest distributors of metal products in the Pittsburgh district is Williams & Company, Inc., with headquarters at Pittsburgh, and branch warehouses in Cleveland and Cincinnati. This company handles a varied line of low carbon steel and nonferrous products and a complete line of electric and oxy-acetylene welding equipment and materials. The sales promotion work of this company during recent months has been interesting to watch. Instead of trying to cover every subject with every prospect in a single mailing, each group of products in their warehouse has been made the subject of a carefully prepared special advertising letter. The two most recent mailings have featured Shelby seamless tubing and the copper and brass products manufactured by the Revere Copper and Brass, Inc. To the inexperienced merchandiser it would be difficult to carry on such a campaign without losing the personality of the firm in the process of selling nationally known brands of merchandise. Williams & Company, however, avoid this danger by using plenty of copy to emphasize the value of their warehouse service to customers. Thus they take full advantage of all of the advertising done by the manufacturers of the things which they sell without sacrificing either personality or dignity.

A. S. M. E. Pressure Vessel Code Discussed at Chicago

On Thursday evening, April 30th, there was held in the rooms of the Western Society of Engineers, Chicago, a joint meeting of the members of the Chicago Section of the A. S. M. E. and of the Chicago Section of the American Welding Society, for the purpose of discussing the proposed specifications for fusion welding of unfired pressure vessels, which are expected to be incorporated into the A. S. M. E. boiler code. The meeting was arranged by Mr. C. B. Cole, secretary of the Chicago Section of the A. S. M. E., and J. I. Banish, consulting engineer, Chicago, was selected to preside. The discussion at this meeting centered mainly around the subject of methods of inspection. Arrangements were made to secure distribution of the latest draft of the proposed specification for fusion welding and to call a future meeting for further discussion of the latest revised draft.

California Welding Works is Expanding

The Commercial Welding Company of Lynwood, California, is carrying out an extensive expansion program at this time by adding 12,000 sq. ft. of working space to their plant at 2750 Norton Avenue.

A general view of the additional building under construction is shown in the accompanying photograph. The framework is entirely arc welded structural steel. The roof and sides are to be of 20 gauge corrugated iron. This unit will bring the total capacity of the plant to about 26,000 sq. ft. The erection of this additional building has been found necessary to take care of the company's increase in storage tank construction business. Included in other products of the company is a complete line of all kinds of gasoline service station equipment, known as the Comwel brand, which include gasoline pumps, greasing units, hydraulic car hoists, etc. All of these are of welded construction.

One of the company welders is shown at work, arc welding the main supporting beams of one of their auto hoists. The piston of this hydraulic hoist is 10⅝ inches in diameter and made of steel tubing accurately machined and polished. A heavy steel plate rests and is securely attached on the head of the piston. The lifting beams in turn rest on top of this plate and are welded to it. The car is thus lifted by the frame, leaving the wheels free.

The Commercial Welding Company has enjoyed a steady growth from the time of its organization in 1920, at which time they started in business in a small 20x20 ft. job welding shop in Los Angeles. A few years ago, the present plant site in Lynwood was purchased, and increasing capacity has been added as the increase in business required. L. L. Highfill is superintendent of the plant.

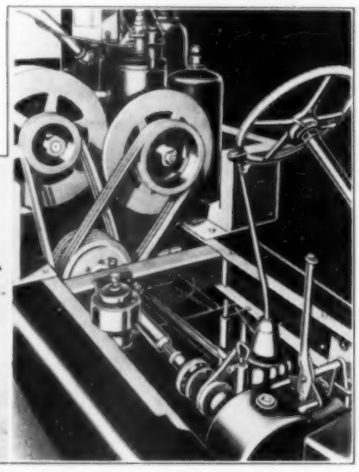
Above: A General View During Erection of the Addition to the Commercial Welding Company Plant. Below: One of the Welders at Work on a Supporting Beam of an Auto Hoist Manufactured by This Company.

Portable Power Plant Saves Space in Service Truck

The portable power take off, manufactured by the Barton Brown Engineering Corporation, 1109 Santa Fe Avenue, Los Angeles, Calif., is made to fill the need for a source of power which is readily transportable. The unit is easily attached to any make of truck and is capable of driving any apparatus which will operate on the power at which the truck is rated. It is designed so that when the unit is installed in a truck every moving part is easily accessible, thus facilitating inspection at all times. Care has been used in planning the oiling system to provide ample oil to all bearing surfaces, as it is needed. Multiple V-belts are used to drive the equipment, thus providing a simple and efficient driving connection between the driven apparatus and the source of power. The drive shaft can be extended the full length of the truck body, making it possible to take power at any point in the truck body that may be desired. The manufacturers state that by using the larger trucks which have 6 cylinder motors of 60 h.p. and up, one can operate as many as four 300 amp. welders or two 220 cu. ft. air compressors. It is not necessary to change the assembly of the truck except to shorten the drive shaft 5 inches in order to insert the gear case. This gear case is of all steel welded construction, heat treated and machined in such a manner that it is oil tight. The gears operate in a bath of oil.

The machine illustrated was designed as a portable electric welder. A Ford truck with 157-inch wheel base was used. The power take off in this unit drives a 300 ampere 93-SK single operator Westinghouse electric welder and a 70 cubic foot per minute Curtis 5¼ x4-inch air compressor. Tank wells are provided for oxygen and acetylene cylinders. This makes a very complete portable welding unit, requiring less than one-half of the capacity of the body of the truck. Receptacles are provided for drop lights, grinders and small electric tools. A 125 volt circuit breaker is installed to protect the electric tools and should a reamer or drill become frozen and overload the line, the circuit breaker would cut off the current.

Below—Truck with Welding Equipment Using Barton Brown Power Takeoff. Right—Details of Power Takeoff.



School for Electric Welders in Boston

The Bay State Electric Welding Company of 1641 Columbus Avenue, Roxbury, Massachusetts, has opened recently an Electric Welding School in connection with their present business.

The courses consist of day and evening classes. The day classes are held in the morning from 9 to 12 and in the afternoon from 1 to 4, from Monday to Friday inclusive. The evening classes meet from 7 to 9 on Tuesday and Thursday. Besides the regular courses, individual instruction is a special feature of this school. This comprises an hour of actual welding each day for five days a week.

The student is not obliged to take consecutive weeks of instruction when he may find it impossible to do so. In other words, a man might continue for one or more weeks, stop for a period, and then later resume where he left off.

In connection with the course in Electric Arc Welding, additional instruction is offered in the fundamentals of operating oxy-acetylene welding and cutting torches.

Demonstration a Feature of Los Angeles Meeting

The April meeting of the Los Angeles section of the American Welding Society was held the evening of April 14th at the Engineers Club. In the absence of Mr. Jeffers, chairman, the meeting was conducted by Mr. Eric Barnett, secretary. Features of the meeting included a talk by Mr. Cooper, of Babcock & Wilcox, on facts regarding the development of the method of examining welds by X-ray. A demonstration was made of an electric welding torch by Mr. Hunt and Mr. Rosenberg, of the Warner Engineering Corp., of Pomona. Much interest was displayed by the members in the ability to braze and fuse various non-ferrous metals. Mr. Nyquist, of the Lincoln Electric Co., donated a number of interesting pamphlets dealing with different phases of welding.

New Pipe Line Contracts Total 290 Miles

The Welding Engineering Company of Bartlesville, Oklahoma, have been awarded contracts for electric welding 100 miles of 18-in. and 20-in. pipe for the Columbia Gas Construction Company, in Indiana; and for 190 miles of 20-in. and 22-in. for the Missouri-Kansas Pipe Line Company in Illinois, the general contractors on this line being Williams Bros., Inc., of Tulsa, Oklahoma. They have also completed the electric welding of approximately 600 miles of 24-in. pipe for the Continental Construction Corporation.

Trade Name "Ascoloy" to Be Discontinued

It has been announced that the trade name Ascoloy, which has been applied to several of the chrome iron and chrome-nickel-iron products of the Allegheny Steel Company, is to be dropped. The various corrosion resisting alloys made by this company will in the future be referred to by the name Allegheny, followed by a number, each alloy having a different number. The only exception is the product popularly known as the 18-8 alloy, which will continue to be called Allegheny metal.

Contractors See Welding of Non-Ferrous Sheets

At the annual convention of the Association of Sheet Metal Contractors, which was held in the Congress Hotel, Chicago, May 12th to 14th, a demonstration of welding methods applicable to several non-ferrous metals was arranged, under the joint auspices of the Steel Sales Corporation of Chicago and the International Nickel Company. Mr. Flocke, welding engineer in the Research Department of the International Nickel Company, demonstrated both arc welding and oxy-acetylene welding of monel metal and nickel. K. F. Thornton, welding engineer from the Research Laboratories of the Aluminum Company of America, New Kensington, Pa., demonstrated the welding of aluminum sheets by both the gas and electric processes. An oxy-hydrogen torch was used for gas welding of

aluminum sheets in this demonstration. These men were assisted by L. J. Sebo and I. C. Demuth, service engineers for the Steel Sales Corporation. The exhibit was managed by W. I. Brockson, Sales Promotional Manager of the Steel Sales Corporation. In addition to a general program of demonstrations, including the use of both processes on all of these materials, time was allowed for any special demonstrations asked for by visitors.

International Acetylene Assn. Plans News Service

At a meeting of the Publicity Committee of the International Acetylene Association, which was held in the rooms of the Association on April 23rd, plans were made to set up a News Service for the benefit of members of the Association and for the trade and technical papers whose readers are interested in the activity of the Association. A tentative arrangement was made to operate its service in the form of a news letter giving information on various phases of the Association activities and on important developments in the oxy-acetylene welding and cutting industry, concerning which information is made available through the International Acetylene Association from time to time. The personnel of the Publicity Committee is well distributed over the country, assuring national coverage of such developments in the news reports.

Electric Welding Discussed by Chicago Section

At a meeting of the American Welding Society, Chicago Section, held in the Palmer House, Chicago, on Friday evening, May 1st, the first paper on the program entitled "Some Resistance Welding Problems" was read by Mr. C. L. Pfeiffer of the Western Electric Company. The second paper, also on the subject of resistance welding, was read by Mr. Walter Anderson of the Taylor-Winfield Company, Warren, Ohio, who also furnished a 15-minute movie reel showing some of the most recent developments in resistance welding in the Taylor-Winfield plant. Several of the typical welding operations described by Mr. Pfeiffer were of the nature of spot or projection welding and involved the welding together of extremely small parts. By contrast, Mr. Anderson's paper referred principally to flash welding and discussed a number of examples of the welding of very large sections, one example of which was the butt welding of 16-in. diameter pipe.

The third part of the program was a paper on the subject of "Controlling Magnetic Blow in Arc Welding" which was read by Mr. Robert Holt, Research Engineer of the Fusion Welding Corporation, Chicago. Mr. Holt explained the principles involved in the phenomenon which is known as magnetic blow, outlined some theories which his experiments had suggested, and showed by means of lantern slides the fundamental principles of a few typical methods of controlling this action of the arc which makes welding procedure difficult in several types of arc welding applications.

At this meeting announcement was made of the election of new officers of the Chicago Section for the ensuing year as follows: Chairman, Mr. H. C. Boardman, Research Engineer of the Chicago Bridge & Iron Works; vice-chairman, Mr. C. C. Whittier, Research Engineer of Robert W. Hunt Company; secretary-treasurer, Mr. M. S. Hendricks, Managing Editor of *The Welding Engineer*.

The May meeting concluded the 1930-31 program of meetings of the Chicago Section. Regular monthly meetings will be resumed next October. Attendance records based upon registrations of members and guests during the past year show that meetings of the Chicago Sections have been better attended than ever before.

A. O. Smith Announces Two New Products

The A. O. Smith Corp. of Milwaukee, Wis., have recently announced two interesting new products. One of these is the Smithsteel highway crossing, which is a new type of permanent steel highway crossing for railroads, and the other is the Smithsteel "Coat of Mail." The latter product is used for armoring concrete flooring, driveways, etc. where heavy shock and wear are encountered. Its design is rather unique in that the surface presents rings instead of the more common straight lines. A continuous mat of any length may be obtained by simply locking together standard panels each of 20 sq. ft. area. In their bulletin No. 511, the manufacturers state that the Smith Steel Coat of Mail tack welded at intervals directly to the steel plate, together with flooring materials, make an admirable floor covering for battle deck construction in buildings, bridges and loading platforms.

Obituary: Porter Pollock

Mr. Porter Pollock, president of William B. Pollock Company, Youngstown, Ohio, died at his home in Youngstown on April 20th. Mr. Pollock was born in Youngstown in 1864, and was the son of William B. Pollock who founded the Pollock Company. He became president of that company in 1913 following the death of his father. Mr. Pollock was a leader in devising improvements, and was recognized as one of the most progressive manufacturers in the steel industry. He took an active interest in the financial life of the community, was a director of two of the local banks and a member of several important local clubs. He was also a member of the American Iron & Steel Institute. His passing is a great loss, not only to the community which he never tired of helping, but also to the steel industry in which he was nationally known.

Allied Welders Associates Organized in San Francisco

A new organization for the benefit of welders and small welding shops in California has recently been formed in San Francisco to be known as the Allied Welders Associates. The purpose of the new organization is to assist welding shops in further expanding their business to include structural steel welding and other work which any shop owner or manager feels hesitant in attempting unassisted owing to lack of experience or engineering ability along that particular line.

The organization will maintain a department for engineering service in designing, drawing plans, furnishing data, etc., essential for any kind of job.

It is thought that the services offered by the new organization will be valuable to many welding shop owners who desire to expand the scope of their services to structural steel and heavier engineering jobs. It is under the management of J. Edmund Davies, consulting engineer. Headquarters will be maintained in the Monadnock Bldg., San Francisco, Calif.

All Set for Outside Work

S. Roy Hall of Jackson, Mich., has recently equipped his welding shop with a complete outfit for outside work. A USL 300 ampere arc welder is mounted in a Chevrolet cab truck, shown in the illustration. This is a

Ready for Any Welding Job Any Place.

snappy looking, clean cut outfit which can travel at high speed and get to the emergency jobs on short notice. Mr. Hall states that the services of this truck are in good demand at this time for repairs of farm machinery and tractors, because there are a great many of such jobs to be done for customers who do not want to bring heavy equipment into town for repairs.

Arlington Welding Conference Well Attended

The continued appreciation of the work done by the Southwest Welding Association through its annual welding conference held at North Texas Agricultural College, Arlington, Texas, annually during the past five years, was in evidence during the conference held there last month, the program of which was published in the April issue of *The Welding Engineer*. Although the registration of visitors did not reach that of some previous meetings, an analysis of the registration showed that an equal number of companies were represented, so that the slight decrease in attendance was accounted for by the fact that some of the firms were not able to send as many representatives to the conference as in previous years.

This conference is sponsored by the Southwest Welding Association, which was organized during the 1930 conference. This year there was a new election of officers, at which Mr. Fred Schramm was elected president, and Mr. W. M. Murphy, Second Vice President. Mr. W. F. Mosher, Jr., continues as First Vice President, and Mr. M. C. Stone, head of the Engineering and Trades Department of North Texas Agricultural college, continues as Secretary-Treasurer. The Association has three classes of membership. Class A includes individuals interested in the Association and its purposes. Class B includes company men, and Class C includes the sustaining membership.

Space for Boston Show More Than Half Gone

More than half the available spaces at the National Metal Exposition which will be held in Boston the week of Sept. 21, have already been sold, W. H. Eisenman, secretary of the American Society for Steel Treating, annual sponsors of the National Metal Congress and Exposition, has announced.

Floor plans and contracts had been sent only to previous exhibitors in the show when the announcement was made, but the space sold totalled 35,000 square feet, equalling or exceeding similar figures for the past four years.

Twenty-five exhibitors reserved more space than previously while only three have reduced their exhibits. General distribution of the floor plans began on April 25.

The National Metal Exposition will be at Boston's spacious Commonwealth Pier. Hotel Statler will be the headquarters for the Metal Congress.

Correction

In an article appearing in the April issue of *The Welding Engineer* which described a canning plant all arc welded, it was erroneously reported that the welding work was done by Wolfe Brothers. The name of the firm which did the work is Hunt Brothers.

Engineering Metals for the Process Industries

The International Nickel Co., Inc., 67 Wall St., New York City, have recently published a 56-page book with the above title which contains an article of exceptional interest by F. P. Huston, Development and Research Dept., International Nickel Co., on the subject "The Design and Construction of Heavy Equipment in Monel and Pure Nickel." Various data and formulae governing the construction of heavy equipment for pressure equipment are included together with photographs and line drawings of the work described. A rather complete discussion of welding by the various methods is included. A timely editorial reprinted from *Chemical and Metallurgical Engineering* opens the book and a catalog section in the back describes and illustrates a wide variety of products made from monel and nickel. Copies are available from the International Nickel Co. at the above address.

Stress Distribution in Welded Steel Pedestals

"Stress Distribution in Welded Steel Pedestals" is the title of Research Paper No. 232 of the Bureau of Standards. It consists of a report by James H. Edwards, H. L. Whittemore and A. H. Stang, sovering a study of the stress distribution in two welded steel pedestals which were tested in compression. These pedestals were designed for the purpose of replacing cast steel pedestals for bridges, because they could be made in a shorter time and without the use of expensive castings. They were designed for a load of 350,000 lbs., and the tests showed that they had a factor of safety of more than 6. Copies of this complete report are obtainable from the Superintendent of Documents, Washington, D. C., at 10c per copy.

Information for Manufacturers in Commerce Dept. Report

A 650-page Commercial Survey of the Pacific Southwest has been prepared by the Marketing Service Division of the Bureau of Commerce. This survey covers the states of Arizona, California, Nevada, Utah and parts of New Mexico, Idaho and Texas. Two hundred and twenty charts and maps, in addition to numerous statistical tables, comprise this volume. Some of the subjects discussed are Agriculture, Forest Resources, Mineral Industries and Manufacturing. In the section which is devoted to market data, there is information on population, the general consumer market, the farm market, the industrial market, a summary of the manufacturers in larger cities, and the location of manufacturing plants by counties as of 1927. This survey is one of a group of studies which is being conducted by the Department of Commerce for the purpose of developing a background of fundamental marketing information on various regions of the country. The book is obtainable from the Government Printing Office at $1.85 per copy.

Booklet on Heat Treating

The Vincent Steel Co., 434 Bellevue Avenue, Detroit, Mich., national manufacturers of grinding wheel drillers for cutting and hardening high speed tool bits and specialists in heat treating, have recently issued a new booklet entitled "Scientific Heat Treating." This booklet is being mailed to all those who are interested in heat treating problems.

A Complete Listing of Mounted Grinding Wheels

What is said to be the first complete listing of mounted grinding wheels has been published in booklet form by the Chicago Wheel Mfg. Company, Chicago, Ill. This is a 16-page booklet, pocket size and full of useful grinding wheel information. Different types of shanks, and the systems used for numbering them, are described, and suggestions are given for the selection of grinding wheels for different kinds of work, with a table of general recommendations for different metals. Another table shows at a glance how many revolutions per minute will secure a rim speed of from 4,000 to 10,000 feet per minute with wheels of different diameters. The booklet concludes with a complete price list of grinding wheels and diagrams showing various shapes and sizes which are supplied, the last page being devoted to a collection of special instructions for securing the best results from the wheels.

Report of Compressive Tests on Boiler H Section Columns

Research paper No. 277, of the Bureau of Standards, gives a report on compressive tests of boiler H section columns by James H. Edwards, H. L. Whittemore and H. S. Stang. The columns tested were 10", 12" and 14". Some of the tests were made of the axis of the columns in line and the others with the outer faces of both upper and lower columns in the same plane. Each combination of H sections and column arrangement was tested with five bearing plates ranging in thickness from 1" to 4¼" using low

loads, giving an average stress in excess of 8,500 lbs. per sq. in. in the smaller column. Tests to failure and repeated load tests were made on a few specimens. The stress in the web of the column was found to be greater than the average stress for the entire H section. The use of heavy 10″ H sections directly over 14″ H sections is not recommended. With the exception of this combination the stress in the columns with plates over 2″ thick was only slightly less than that with 2″ plates, and the ultimate strength of the specimens tested to failure was about the same as that of a single H section, having cross sectional dimensions of the smaller column of the specimen and a length equal to that of the specimen. Complete copies of the report may be obtained from the Superintendent of Documents, Washington, D. C., at 15c each.

Imperial Brass Catalog No. 560 Being Distributed

The Imperial Brass Manufacturing Co., 1200 W. Harrison St., Chicago, Ill., are now distributing their catalog No. 560, a 32-page book which lists and describes the complete line of oxy-acetylene welding and cutting apparatus, supplies and accessories of their manufacture. Several outfits for various purposes are listed.

Sight Feed Acetylene Generators Described in Bulletin

The Sight Feed Sales Co., Norwood Bldg., Dayton, Ohio, have recently published bulletin No. 31 which describes their line of Sight Feed Portable Acetylene Generators. A feature of this line is that a standard size of carbide is used which is always visible in a glass hopper at the top of the unit, giving the operator a constant check on the amount of gas that is still available as well as the amount used on a given job. Specifications and complete descriptions are included in the bulletin.

Manual of the Electric Torch Prepared by Warner

Warner Engineering Corp., Pomona, Cal., manufacturers of the Weco-Weld electric torch, have published the "Manual of the Electric Torch," a 40-page booklet describing the operation and applications of this piece of equipment. The first two sections are devoted to a brief description of the welding processes and their applications and a more extensive study of the electric torch and the technique of its use. The element of costs are then taken up and followed in the next three sections by descriptions of electric torch hard soldering which includes bronze, silver soldering, etc., the welding of like metals, including cast iron, aluminum, special steel alloys and the stainless steels, and is concluded with a discussion of hard surfacing. The last section includes charts and tables indicating how the electric torch is to be used; melting points of various metals and alloys; wire gauges, etc.

New Hobart Bulletin Describes Products and Uses

Bulletin No. E-24 has just been completed by Hobart Brothers, Troy, Ohio, manufacturers of electric arc welders, supplies and accessories. The bulletin, in loose leaf form, pictures and describes the applications of arc welding to a wide variety of products and lists the many advantages of this type of construction. Among other things it is pointed out that noisy, nerve-straining riveting can be almost entirely eliminated and fabrication costs are greatly reduced, in addition to turning out a stronger unit in less time. The last portion describes the line of Hobart welders and prices of accessories.

New Control to Speed Up Spot Welding

Intermittent line and spot welding with interruptions as high as 1,000 per minute and even higher are claimed to be possible with a new type of control equipment announced by the General Electric Company. This new control uses "thyratron" tubes instead of contactors for interrupting the flow of current.

In addition to the advantage of the high speeds which can be obtained—speeds hitherto impossible with mechanical interruptors or magnetic contactors—contactor wear is eliminated, both on the contactor tips and the entire mechanical assembly. As a result, considerable time is saved, time hitherto spent in replacing worn contactor tips. In some installations, such replacements take place at the end of every eight-hour shift.

The theory of the new control is as follows: In series with the primary of the welding transformer proper is placed the primary of a series trans-

The Thyratron Control for Spot Welding Equipment.

former whose secondary is wound for a high voltage. Connected to the high-voltage winding are a pair of thyratrons which, when conducting, virtually short circuit the high-voltage winding. When the high-voltage winding is short circuited, the impedance of the primary or low-voltage winding of the series transformer is very low, thus permitting approximately full load current to pass to the primary of the welding transformer proper.

Conduction or non-conduction of the thyratrons is controlled by imposing an

A Line Welding Equipment with Thyratron Control Panel at Right.

"in-phase" or "out-of-phase" voltage on their grids; this is accomplished mechanically by the closing or opening of a small single-pole switch. In an actual installation on an intermittent line welding machine, this switch takes the form of a cam-operated switch. The cam which operates this switch may be driven by a variable-speed motor the speed of which determines the number of welds per minute.

The new control consists of two essential parts: the series transformer and a control panel. The series transformer is ordinarily a standard distribution transformer and is mounted at a point conveniently near the control panel. On the control panel are mounted two hot-cathode thyratrons, the filament transformers, grid transformer, a time-delay relay, and the necessary resistors, capacitors, etc.

In starting the equipment it is necessary to permit the thyratron cathodes to reach an operating temperature before power is supplied to them. This is accomplished by the time-delay relay on the control panel.

The new control is expected to find its greatest value on intermittent line or spot welding operations which are a part of continuous, straight-line production where speed is an important factor.

Announce Improvements in Copper-Arc Electrode

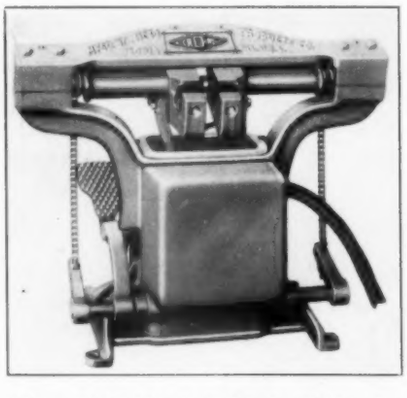
It has been announced by the American Arc Welders, Roseau, Minn., manufacturers of arc welding electrode specialties, that improvements have been made in the production of the electrode, which they have named Copper-Arc, which have been beneficial to both working qualities and results. This material is a flux coated copper wire. The most important field for usefulness, according to the manufacturers, is for cold arc welding of cast iron. Weld strengths up to 45,000 pounds are said to be obtained with it. This electrode is also recommended for arc welding malleable iron, copper, and brass. The manufacturers state that the flux coating, which has been perfected for this rod, allows the operator to lay a continuous bead of any length on cold cast iron without any checking.

New Line of Mechanically Operated Cutting Torches

The Hancock-Croydon flame cutting and profiling machines have recently been announced by the American Oxycop Company, 430 Woodbridge Street, Detroit, Michigan. The standard machine for profiling tool dies and similar articles has the cutting mechanism attached to the two ends of a U-frame held in position so that the two arms of the U are in the same vertical plane. A motor driven tracing wheel is mounted at the end of the upper arm and the cutting torch is mounted on the lower arm. A table is provided just below the tracing wheel so that many shapes can be cut without templates by guiding the tracing wheel along a drawing spread on the table. The cutting torch is of special construction with remote control so that the heating and cutting oxygen are controlled from a single lever placed opposite the main switch. Once the preheating flame has been set by means of the preheating valve, the lever does all that is necessary to start and stop the cut. The standard torches supplied with this apparatus are made for use with either coal gas or hydrogen as a fuel, but torches can be provided to use acetylene as a fuel gas if necessary. The machine can be fitted for work with templates and templates are readily made from strips of aluminum with special equipment provided for use with this machine. For profiling over an uneven surface, a special attachment can be fitted which enables the operator to raise or lower the cutting torch while actually cutting. The machine is said to cut material up to 8 inches thick, with no limit as to the shapes which can be cut. The outfit is made in four standard sizes, having cutting areas ranging from 18x18-inches up to 60x30-inches. A four page illustrated circular has been prepared showing some of the shapes which can be cut with this apparatus and giving a table of oxygen consumption, pressure, cutting speed and costs for metal of different thicknesses ranging from ¼ in to 8 ins.

Micro Weld Model K for Non-Ferrous Metal

A flash welder for non-ferrous metals including copper, aluminum and zinc has recently been announced by the Micro Products Company, Peoria, Illinois. This is described as a precision machine with the operations arranged for a minimum dependance on the human element. It is operated by a single foot pedal leaving the hands free to handle the materials. The machine is adaptable for various sizes without major adjustments, the range being from ⅜-in. to ⅝-in. in size. The transformer capacity is 50 kilowatts and the machine weighs 500 lbs. It can be supplied in any voltage or cycle needed. The manufacturers state that practically no annealing occurs after welding, which makes high speed drawing and cold working of the welded stock entirely practicable, and that maximum strength welds are obtained with ends cut only with ordinary bolt cutters. Special alloys are used in the dies and other parts affected by heat and molten metal.



Micro Weld Model K Flash Welder for Non-Ferrous Metals.

New Spot Welders Made by Alternarc Manufacturers

Announcement has been received of a new line of electric spot welders recently developed and placed on the market by the Electric Arc Cutting & Welding Company, Newark, New Jersey, manufacturers of A. C. and D. C. welding machines and welding electrodes. The name "Electroweld" has been given to the new type of equipment. This machine is made up without using castings, being completely built of steel and electrically welded. The model shown in the accompanying illustration gives an idea of the general appearance of the equipment. Standard models are furnished with throats up to 48 inches and the manufacturers state that this can be increased on special order. The machine is said to be light enough to use for portable duty and can also be furnished with a base for permanent mounting. The 20 kilowatt size, which is the one shown in the illustration, will weld two pieces of ⅛-in. steel. It is so designed that it can be changed from a spot welder to an arc welder by moving a switch handle, the transformer having 200 ampere capacity.

The New "Electroweld" Spot Welder.

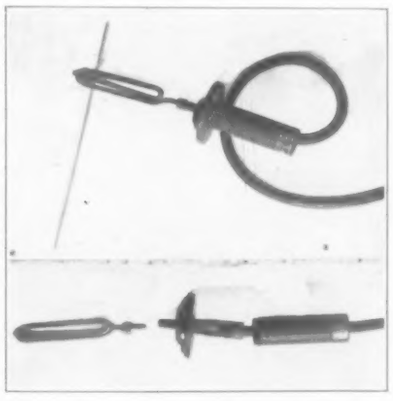
New Hollup Electrodes for Fast Welding

Two recent developments of the Hollup Corporation, 3333 W. 48th Place, Chicago, Ill., are new wires for high speed manual arc welding. These materials have been developed especially to meet the requirements for fast production together with good strength and ductility. One of these two electrodes is called No. 274. This is a high speed wire which the manufacturers state operates easily on both negative and positive polarity. The coating is impregnated with materials which give a high arc resistance which results in a rapid melting rate with deep penetration. When used with positive polarity, a little more heat is concentrated in the electrode so that the melting rate is somewhat greater. The arc voltage is higher in this case, making the arc less subject to disturbances by movement of the hand.

The other new material is the Hollup 3-L lightning electrode. It is stated that the high speed of this electrode is obtained from a special coating which provides both a high degree of arc stability and a high arc voltage. The special coating also projects slightly beyond the end of the electrode, furnishing a certain amount of protection for the arc while the metal is being transferred. The deposited metal has a smooth surface appearance. This electrode is recommended for all downhand speed welding, such as tank roofs, furnace jackets, penstocks, and general steel plate work. It is also recommended that this electrode be used with reverse polarity only.

Electrode Holder Has Replaceable Grip

A new type of electrode holder for metallic arc welding, called the La-Roc, has recently been developed and put on the market by the Electric Iron Stand Mfg. Co., 3410 W. 63rd Street, Chicago, Ill. The grip of this holder is made of a heavy piece of copper rod bent somewhat in the shape of a wire paper clip. This holds the electrode with a friction grip in any position. The time required for changing electrodes is very short, because when a new electrode is inserted, the old one simply drops out. The holder has a hollow fibre handle providing a generous air-cooling space. The cable is not soldered but is fastened into the handle with a strong metal wedge held in place by a screw. A special feature of the electrode holder is the fact that the copper grip is easily replaceable. All that is required for replacement is the loosening of a small nut at the base of the grip, which allows the old one to be taken out and a new one put in place in a few seconds. There are no springs and very few parts. The construction is simple, but the holder is made strong for continuous duty. The retail price is $5.00 each, and arrangements are being made for distribution through the welding supply trade.



Above—The New LaRoc Electrode Holder. View Below Shows Simplicity of Construction.

A Folding Face Shield that Fits the Pocket

One of the latest accessories announced by the Lincoln Electric Company, Cleveland, Ohio, is a folding, portable hand shield for arc welders. This shield, the construction of which is shown clearly in the accompanying illustration, is made of fine, finished, black cow-hide and fitted with a "Lincoln Supervisibility" welding lens. The strip of fiber shown in the center keeps the shield spread out when in use and turns so as to permit folding when it is not in use. Below this strip can be seen a leather loop which serves as a handle. When in use, the hand holding the shield is protected from the radiation of the arc. This folding shield is not intended for use by operators on continuous duty. It will be very convenient, however, for inspectors, service-men, salesmen, teachers, superintendents, supervisors, etc., who are obliged to observe arc welding operations frequently for short periods of time and for whom it is a considerable nuisance to have to carry around a large face shield. The price of this shield is $5.00.

Another convenient accessory in the Lincoln line is a special electrode carrier for structural welders or anyone engaged in large tank or construction work. This is a leather case large enough to accommodate about 10 lbs. of electrode and divided into two compartments so that two sizes of electrodes can be carried. With this is furnished a leather belt 1½ inches wide. The price of this electrode carrier is $5.00 each.

A Special Electrode Carrier Is Shown on the Left. The Hand Shield on the Right Folds Up to Fit Into the Pocket.

New Spark-Resisting Glass for Eye Shields

A new process glass for cover glass use in welding eye shields has been placed on the market by the Carter-Lockard Company of Los Angeles, California. This glass, known by the trade name of "Klearsite Koverglas," has been specially processed by a solution for which a patent has been applied. By this special process of treating, it is claimed that the glass is made practically immune from adhering sparks and flying bits of metal which ordinarily stick to the glass, and which eventually obscure or cloud the vision of the welder. According to the manufacturers welding by either electric arc or oxy-acetylene may be done using this glass without the objectionable feature of the burning sparks, etc., adhering to the cover glass of the shield or goggles. The new glass is also made to insulate against heat, so that there is little pos-

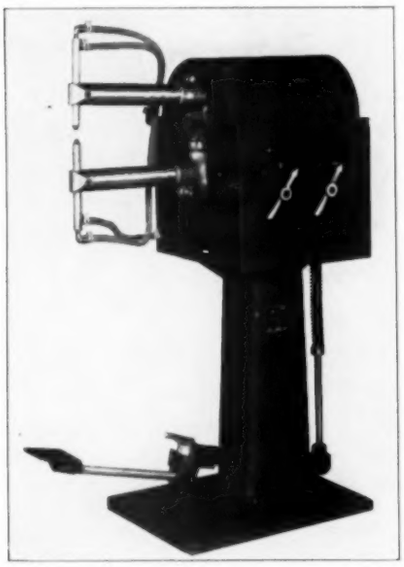
sibility or danger of the glass being broken by the hot metal adhering to it. This also makes possible an added saving in breakage of colored lens.

Some of the advantages claimed for this new product are: The glass remains clear at all times, which gives the operator clear visibility, eye strain is reduced to a minimum, the insulated feature minimizes the danger of breakage, both of the cover glass and colored lens.

The Carter-Lockard Companay states that at the present time some of their glasses have been in actual use in hoods for over a month and show no signs of the spark-resisting process breaking down. The glass is perfectly transparent and is made up in standard sizes.

A Spot Welder for Light Duty

The latest spot welder announced by the Lenney Machine & Mfg. Company of Warren, Ohio, is the Midget Spot Welder which is said to fill all requirements for a light duty, light weight, low priced machine. The manufacturers claim that this machine has a continuous capacity to weld two pieces of 16 gauge stock and an intermittent



The Lenney Midget Spot Welder.

capacity of two pieces of ⅛ inch stock and that it will cover practically the entire range of work required in most small shops. This machine is compact, requiring 16 inches by 22 inches floor space for the 12 inch throat. It has a 7½ K. V. A. capacity transformer with cast secondary and pancake coils. It is equipped with six step regulation, is swivel treadle, and water-cooled points.

New Device Offered for Saving Fluxes

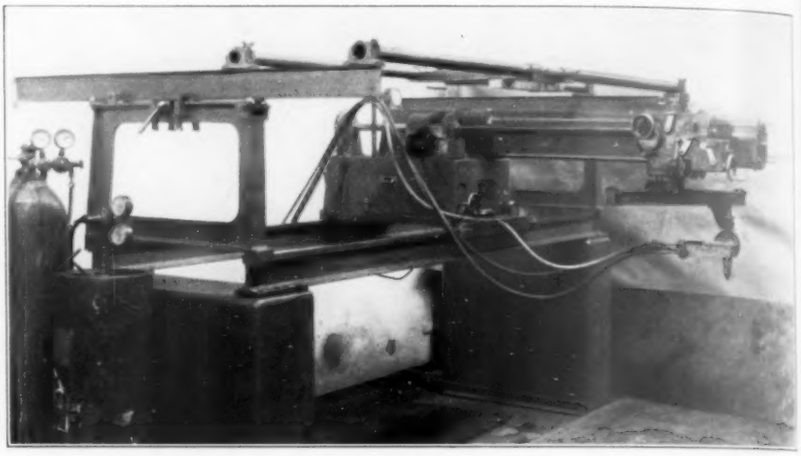
The Omaha Welding Company, Omaha, Nebr., have recently put on the market the M & M Flux Saver. This device is a small, cup-shaped casting with a wide, flaring bottom. The inside is tapered toward the bottom so as to permit reaching the contents and at the same time the center of gravity of the container as near the bottom as possible and this makes it difficult to tip over. The object of this special container is to provide a means for the welder to use a small quantity of flux which has been kept in its original state instead of using flux out of the original can. In some cases where the flux is kept in the original can, it becomes heated by the constant dipping of the welding rod and loses some of its important properties as far as the weld is concerned. It is also quite a common occurrence when no special container is used for the original can to be tipped over and a part of the flux lost. This container has the advantage over a number of homemade devices in that the welding rod will always find flux in the tapered bottom. In almost all cases, where a flux is used, it is advantageous to have a separate container because a full can is seldom used in one day, so it is really not necessary to have the contents of the original package available. If, however, the original package is used and is tipped over a good deal more of the flux is lost than would be the case if just enough for the day's work had been taken out and used from a device such as the one described.

The M & M Flux Saver.

"S-U" Automatic Shape-Cutting Machine

The "S-U" shape cutting machine recently introduced by J. C. Paulus & Co., Philadelphia, Pa., is designed as a combination compound traversing-head and template cutting machine to execute practically any form of cut. It contains an enclosed motor of ¼ H. P., direct connected to a stepless friction drive capable of moving the burner at any desired speed to suit the thickness of the metal to be cut. A Tachometer, placed where it can clearly be seen, allows the operator to set the travel of the torch for the proper speed before setting the machine in motion.

The "S-U" is not purely of the template type as many cuts such as are frequently used, such as straight cuts, traverse, any right angle, 45 degree angles in any direction, circles and bevels can all be made independently of each other or in sequence without template and without interrupting the cut, by the simple turn of conveniently placed control levers. Any geometrical shape can be cut by the use of cheap and easily made templates.



The "S-U" Automatic Shape Cutting Machine.

For longitudinal cuts the whole machine moves along the tracks and the length of travel is unlimited as the tracks can be made any desired length. There are many in use in Germany sixty feet long. The cross cut is limited to the size of the traverse head, the three different sizes allowing 4½ feet, 6½ feet and 8 feet respectively.

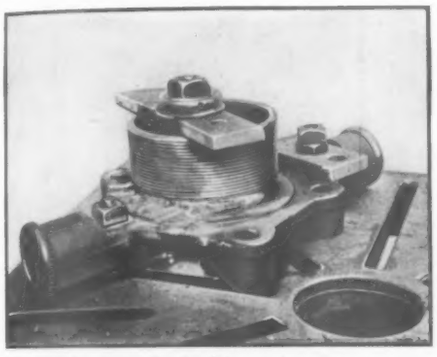
News of the Industry

J. P. Mitchell, former owner of the Clark Welding Works in Pasadena, California, has been engaged by the California Institute of Technology to

The pipe-stock was broken completely in two.

ONLY 20 MINUTES

to weld this pipe-stock with TOBIN BRONZE



The casting was locked in a clamp, to assure perfect alignment.

30 minutes for preparation . . . 20 more for actual welding . . . and this 5″ pipe stock was ready for service again. Tobin Bronze Welding once more proved its worth in an emergency. On jobs like this, where speedy repair is vital, Tobin Bronze saves time and money. The alloy flows freely at a relatively low temperature (1650 degrees F.), and preheating is seldom necessary.

Publication B-13, containing full information on all Anaconda Copper Alloy Welding Rods, will be mailed on request.

* * *

Anaconda Welding Rods are available through leading distributors of welding equipment and supplies. For those requiring small quantities, Anaconda Welding Rods can now be obtained in clearly labeled ten-pound packages.

There is a suitable Anaconda Filler Rod for every bronze-welding purpose. Principal Anaconda Welding Rods, with their melting points, are listed below:

for oxy-acetylene welding

*Tobin Bronze**	*1625°F*
Manganese Bronze	*1598°F*
Brazing Metal	*1634°F*
Naval Bronze	*1625°F*
Electrolytic Copper	*1981°F*
Silicon Copper	*1981°F*
Phosphor Bronze	*1922°F*
*Everdur**	*1866°F*

for arc welding

Silicon Copper	*1981°F*
Phosphor Bronze	*1922°F*
*Everdur**	*1866°F*

**Reg. U. S. Pat. Off.*

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handle and supervise the welding for that institution. Mr. Mitchell will have charge of the welding department of the Astro-Physics Department Machine Shop. Included in his duties will be the carrying out of plans, etc., for the welding construction on a new 200-inch telescope which the institute contemplates erecting in the near future.

A new welding shop has opened for business in Taft, Calif., under the joint partnership of R. B. Conner and L. W. Knight, which will be known as the Bob and Lee Shop. The location of the new shop is what was formerly known as the Lawrence Massey Shop. The new partners will feature all kinds of welding together with blacksmithing and repair work. Installation of electric welding equipment is anticipated in the near future.

W. I. Brockson, Advertising Manager of the Steel Sales Corporation, Chicago, is the author of an interesting article in the May issue of the Inland Printer, which describes several types of salesmen and sales methods.

W. J. Cooper Company, 40 Lancaster Street, Boston, Mass., has recently been appointed distributors for the Harris Calorific Company, Cleveland, Ohio.

Clinton Swift, formerly connected with the Research Department of the Westinghouse Electric & Mfg. Co., recently resigned to accept a position in the Research Department of the American Brass Company at Ansonia, Conn.

For the first time in its history, the American Society for Testing Materials will sponsor an exhibit of testing apparatus and machines in conjunction with the annual meeting of the Society, which will be held at the Stevens Hotel, Chicago, June 22nd to 26th. The exhibit is limited to equipment and apparatus used in the testing of materials and products and recording and control equipment which is used in testing.

The Moline Welding Shop, Moline, Ill., who have operated as a job welding shop for the past eighteen years, have recently started selling the following lines of equipment: Harris Calorific Company oxy-acetylene equipment; Hobart Brothers arc welding equipment and Tube-Turns. They have a sales force of five men in the field at the present time.

Among the specialized courses in mechanical arts offered during the summer session of 1931 at Colorado Agricultural College is a welding course which includes gas and arc welding. Mr. A. G. Odell, lecturer and director of welding at the Denver Opportunity School, Denver, Colo., will have charge of this course. It runs from June 15th to July 24th.

Paul Moffitt, a welder for the Smith-Winchester Hardware Company, Jackson, Mich., has just completed the fabrication of a warehouse rack for holding stocks of cold rolled shafting. He states that work in Jackson shows signs of picking up, and the outlook for the balance of the year is encouraging.

M. Kelly, of the Kelly Welding Works, San Diego, Calif., has closed his shop at 418, 10th St., and transferred his equipment to the plant of the standard Iron Works, with whom Mr. Kelly has made arrangements to handle all welding contracts for that company. The Standard Iron Works feature general iron work of all kinds which includes structural steel.

R. R. Canbee, who owns a welding and machine shop in McKettrick, Calif., recently opened a branch shop in the Belridge oil field. General oil field welding service of all kinds will be featured. L. J. Evans is in charge of the new shop.

R. J. Dunlap recently opened a new welding shop at 2220 "L" St., in Bakersfield, Calif. Mr. Dunlap will do all kinds of welding, both oxy-acetylene and electric, and will specialize on oil tool welding. Mr. Dunlap was formerly associated with the Alco Oil Tool Co., of Compton.

An eight-inch welded pipe line is being laid by the Atlas Pipe Line Company, Inc., from Shreveport, La., to the east Texas fields. All except about fourteen miles of the line will be handled by the Atlas Company. The fourteen miles will be constructed by Simmons & Nusser, contractors. It is an all-electrically welded job. The Atlas Company have just received delivery on a fleet of ten Lincoln 300 ampere arc welders, which were sold by Woodward, Wight & Co., Ltd., of New Orleans, La.

The Bakersfield (Calif.) branch of the Spartan Steel Co., whose headquarters are located at Compton, was recently transferred to Willard R. Moss and Grady Cowart. The new management will continue to handle and service the Spartan products, which includes various types and kinds of oil well digging bits, core barrels, etc., and will also feature general welding work of all kinds. Mr. Cowart will act as manager of the new concern.

The Associated Oil Company recently equipped a welding shop for the company's welding work in connection with their drilling activities in the Belridge (California) oil field. This company is drilling several wells in that field.

The Williamson Welding Works, with headquarters at San Bernardino, Calif., who own and operate a number of shops in different cities of the western states, recently opened a new branch shop in Dallas, Texas. This concern specializes in car starter flywheel dentistry.

Carl A. Pallister, formerly associated with the Paco Corporation of Los Angeles, California, recently opened a new welding shop at Lost Hill. The new shop is known as the Central Welding Co., and features oil field welding of all kinds. Mr. Pallister also distributes the Paco line of oil tools in the Lost Hills field.

P. D. (Pete) Erwin, of the Union Oil Company in California, has recently been transferred to the Maricopa Field Division Shop, as shop superintendent. Mr. Erwin, who was formerly in the transportation department of the company at Santa Fe Springs, is to have charge of field tools and company welding in the Maricopa district.

The Taft (California) Union High School recently opened a Course of Instruction in welding and are running both day and night classes. About 64 are enrolled in the day class and about 20 are receiving instruction in the evening class. Very thorough instruction is given, the course being two years, and includes acetylene, electric arc, atomic hydrogen, and all of the newest developments in the application of welding. The shop is one of the best equipped in the state. All racks, tables, jigs, and similar equipment used in the shop has been made by the student welders in their practice work. H. S. Nix is instructor in charge of the classes.

A new welding shop is being opened at 39th and Chester Streets in Bakersfield, California, under the joint partnership of G. A. Thompson and R. G. Froliech. The new shop which will be under the management of Mr. Thompson, will be known as the San Joaquin Welding Co. Mr. Thompson will handle general welding of all kinds, specializing in agricultural implement repair work, hardfacing, etc. The management anticipates the installing of electric welding equipment in the near future. Mr. Thompson was formerly associated with the Candee Iron Works at McKettrick.

The Standard Specification of the Welder *and* Cutter

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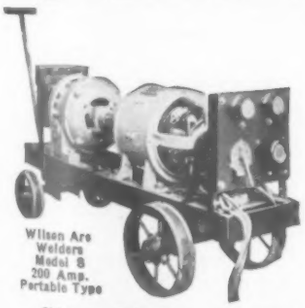

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Electric welding plant with air compressor, acetylene cutting outfit, cables, airhose and tools, mounted on 3 ton truck. Ideal outfit for Marine, Industrial or Oil field purpose—A1 condition. Photo on request. Write Box 417, The Welding Engineer.

Welding and Machine Shop—Established 11 years, only exclusive shop in growing city of 35,000 population. Owner wishes to retire. Priced at a sacrifice. Address Electric Welding Works, 16 W. Haley St., Santa Barbara, Cal. t.f.

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1—300 ampere General Electric
1—300 ampere Lincoln
1—250 ampere General Electric
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All are ball bearing machines, first class shape. Motors 220 volts, direct current. Apply Quaker City Iron Works, Inc., Richmond and Tioga St., Philadelphia, Pa. 3x's

Bargain price on gas engine driven arc welders—We have 17 gas engine driven arc welding sets which have been released from a large rental job in Philadelphia. Will make bargain price to save trucking back. Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J.

POSITIONS WANTED

Sales Director—Young man thoroughly experienced in organizing territories, hiring and instructing men. Thoroughly familiar with arc welding machines and welding wire. Can show satisfactory ability to get results. Experience includes advertising and promotion work. Location close to Chicago desired, but not absolutely necessary. Address Box 418, The Welding Engineer.

Arc Welder—Trained by Lincoln Electric Co., 21, single, 3 years experience tank, boiler and structural work. Desire position in industry where first class results are demanded. Address Box 419, The Welding Engineer.

Combination Welder and Blacksmith—Experienced in all kinds of welding. Desire permanent position with reliable firm employing only one welder who takes full charge of department. Address Box 420, The Welding Engineer.

Pipe Specialist—A1 Gas welder; passed most rigid tests in oil fields. Familiar with No. 7, No. 1 H. T. and Lindeweld rods. Able overhead and bell hole welder. Desires steady position, preferably with oil company who needs a man who can deliver. Go anywhere. W. F. Johnson, 503 Main St., Burlington, Wis.

Foreman—13 years in charge of welding department for one firm doing refrigeration and engine building. Can design jigs and all essentials for well regulated department. Know manufacture of cast iron, steel and bronze; expert on aluminum, pipe and cast iron cutting. Single, go any place. E. A. Johnson, 5154 August Blvd., Chicago.

Position Wanted—Welding superintendent with 13 years experience production welding including gas, arc, shielded arc and automatic. Has built up welding department in present position. Chicago location preferred. Address Box 421, The Welding Engineer.

Position Wanted—Mechanical and electrical engineer with 22 years experience; 4 years experience in design of machinery for welded construction; 2½ years experience in supervision and inspection of important welding operations. Can furnish excellent references. Address Box 422, The Welding Engineer.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of The Welding Engineer, published monthly at Chicago, Illinois, for April 1, 1931.

State of Illinois, County of Cook, ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared H. S. Card, who, having been duly sworn according to law, deposes and says that he is the Editor of The Welding Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, G. H. Mackenzie, Chicago, Illinois; Editor, H. S. Card, Chicago, Illinois; Managing Editor, H. S. Card, Chicago, Illinois; Business Manager, H. S. Card, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) The Welding Engineer Publishing Co., 608 S. Dearborn St., Chicago, Ill.; G. H. Mackenzie, 7321 So. Shore Drive, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is..... (This information is required from daily publications only.)

H. S. Card, Editor.

Sworn to and subscribed before me this 31st day of March, 1931.
(Seal.) G. W. Tyler.
(My commission expires June 25, 1932.)

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